Section 5
NOVRAM SETUP AND SUBSYSTEM TESTING

5.1 Overview

This section describes how to set the NOVRAM parameters to configure the UC07/08 Host Adapter for your system. Including this overview, this section is divided into seven main subsections:

Subsection	Title
5.1	Overview
5.2	NOVRAM
5.3	F.R.D.
5.4	Starting F.R.D.
5.5	Disk F.R.D.
5.6	Tape F.R.D
5.7	Integration and Operation

5.2 NOVRAM

The UC07/08 utilizes an onboard 512 Byte Non-Volatile Random Access Memory (NOVRAM) to store various pieces of subsystem configuration information needed by the UC07/08 to determine device types, device addresses, device configurations, and to enable or disable various user-programmable options. Diagnostic programs embedded in the firmware of the UC07/08 (Firmware Resident Diagnostics) provide the ability to access the NOVRAM.

5.3 F.R.D.

F.R.D. is an interactive, menu-driven utility program that allows the user to communicate with the UC07/08 via the host CPU console device. Using F.R.D., the user is able to perform various functions, such as loading the NOVRAM with configuration data, formatting and surface verifying the media on magnetic drives, and initializing RCT areas on both the magnetic and optical media.

In addition to these preparation capabilities, F.R.D. also can be used to perform reliability testing of the subsystem. While not designed to isolate problems to the component level, these reliability tests can aid in isolating a problem to either the SCSI side or the host side of the system.

The UC07/08 actually contains two separate versions of F.R.D., Disk F.R.D. and Tape F.R.D. Each has a separate set of menus, NOVRAM functions, and command options appropriate to either disk or tape requirements. The F.R.D. program that runs when F.R.D. is started depends on whether the UC07/08 is set for MSCP (Disk) or TMSCP (Tape) emulation.

5.4 Starting F.R.D.

F.R.D. is designed to be run from the host CPU console in an offline mode, that is, with the host's normal operating system not running. F.R.D. is started by issuing a special command sequence via console ODT. The startup procedure is identical for either Disk F.R.D. or Tape F.R.D. There are two methods for starting F.R.D., depending on the host CPU type.

5.4.1 Starting F.R.D. on a MicroVAX II or MicroVAX III

F.R.D. is started by issuing a special command sequence via console ODT. To start F.R.D. on a MicroVAX, first apply power to the system. Put the system in console mode, then enter the following commands via the host console in response to the > > > prompt:

```
> > > I                                    !BUS INIT
> > > D/P/W 20001F40 20 < CR >             !ENABLE MEMORY
> > > D/P/L 20088000 80000000 < CR >       !SETUP MAP 0
> > > D/P/L 20088004 80000001 < CR >       !SETUP MAP 1
> > > D/P/W 2000XXXX 1 < CR >              !INIT CONTROLLER
> > > D/P/W 2000YYYY 3003 < CR >           !ENABLE SPECIAL MODE
> > > D/P/W 2000YYYY 4401 < CR >           !UPLOAD DRIVER
> > > S  80 < CR >                         !START DRIVER
```

NOTE: XXXX and YYYY are offsets dependent on the address of the UC07/08 controller. See Tables 5-1 and 5-2 for appropriate values.

For a GPX terminal, enter the following commands via the host console in response to the >>> prompt:

```
>>>I                                   !BUS INIT
>>>D/P/W 20001F40 20<CR>               !ENABLE MEMORY
>>>D/P/L 20088000 80000000<CR>         !SETUP MAP 0
>>>D/P/L 20088004 80000001<CR>         !SETUP MAP 1
>>>D/P/W 2000XXXX 1<CR>                !INIT CONTROLLER
>>>D/P/W 2000YYYY 3003<CR>             !ENABLE SPECIAL MODE
>>>D/P/W 2000YYYY 4401<CR>             !UPLOAD DRIVER
>>>S  82<CR>                           !START DRIVER
```

NOTE: XXXX and YYYY are offsets dependent on the address of the UC07/08 controller. See Tables 5-1 and 5-2 for appropriate values.

Table 5-1. MicroVAX Offsets for MSCP Emulation

UC07/08 Bus Address	XXXX	YYYY
17772150	1468	146A
17772154	146C	146E
17760334	00DC	00DE
17760340	00E0	00E2
17760344	00E4	00E6
17760350	00E8	00EA
17760354	00EC	00EE
17760360	00F0	00F2
17760364	00F4	00F6
17760370	00F8	00FA
17760374	00FC	00FE
17760400	0100	0102
17760404	0104	0106
17760410	0108	010A
17760414	010C	010E
17760420	0110	0112

Table 5-2. MicroVAX Offsets for TMSCP Emulation

UC07/08 Bus Address	XXXX	YYYY
17774500	1940	1942
17760404	0104	0106
17760410	0108	010A
17760414	010C	010E
17760444	0124	0126
17760450	0128	012A
17760454	012C	012E
17760504	0144	0146
17760510	0148	014A
17760514	014C	014E
17760520	0150	0152
17760524	0154	0156
17760530	0158	015A
17760534	015C	015E
17760540	0160	0162
17760544	0164	0166

5.4.2 Starting F.R.D. on an LSI-11 System

To start F.R.D. on an LSI-11 system, first halt the processor. Then enter the following commands in response to the ODT prompt (@):

```
@ 177xxxxx/ 000000 1  <LF>
@ 177yyyyy/  5400 30003  <CR>
@/000400 42000<CR>
@ 177yyyyy/ 2000  <CR>                          !TEST FOR 2000
@ 200G
```

NOTE: XXXXX and YYYYY are offsets dependent on the address of the UC07/08 controller. See Tables 5-3 and 5-4 for the appropriate values.

Table 5–3. LSI-11 Offsets for MSCP Emulation

UC07/08 Bus Address	XXXX	YYYY
17772150	72150	72152
17772154	72154	72156
17760334	60334	60336
17760340	60340	60342
17760344	60344	60346
17760350	60350	60352
17760354	60354	60356
17760360	60360	60362
17760364	60364	60366
17760370	60370	60372
17760374	60374	60376
17760400	60400	60402
17760404	60404	60406
17760410	60410	60412
17760414	60414	60416
17760420	60420	60422

Table 5–4. MicroVAX Offsets for TMSCP Emulation

UC07/08 Bus Address	XXXX	YYYY
17774500	74500	74502
17760404	60404	60406
17760410	60410	60412
17760414	60414	60416
17760444	60444	60446
17760450	60450	60452
17760454	60454	60456
17760504	60504	60506
17760510	60510	60512
17760514	60514	60516
17760520	60520	60522
17760524	60524	60526
17760530	60530	60532
17760534	60534	60536
17760540	60540	60542
17760544	60544	60546

When the appropriate starting procedure is completed, F.R.D. identifies itself by displaying the controller type and firmware revision. Then, it displays the menu options. See subsection 5.5 for more information on using Disk F.R.D. or subsection 5.6 for Tape F.R.D.

5.4.3 F.R.D. Conventions

F.R.D. uses the following keyboard conventions:

<CR>	required to terminate operator inputs
<Ctrl C>	aborts the current operation and returns to the main menu

A minimum delay of 10 seconds might occur between the <Ctrl C> and the next display. During some verify operations, the delay might be considerably longer because the abort is delayed until the successful completion of the current command.

In this subsection, operator responses to Disk F.R.D. prompts appear in **bold** print. The symbols used in this subsection are listed below with their meanings:

<CR>	carriage return key
<LF>	line feed key
<Ctrl C>	Ctrl key and the letter C pressed at the same time

5.4.4 Terminating F.R.D.

To terminate F.R.D., choose one of the following:

- Press the BREAK key
- Re-initialize the system, or
- Halt the CPU.

You can restart the diagnostics from a halted condition if you have not changed the memory contents. On an LSI-11 system, enter **200G** at the ODT prompt. On a MicroVAX system, enter **S 80**. For a GPX terminal, enter **S 82**.

5.5 Disk F.R.D.

Once started, Disk F.R.D. will display the menu shown in subsection 5.5. The Disk F.R.D. Menu has been specially tailored to offer only those functions appropriate to the preparation and testing of magnetic or optical disk drives.

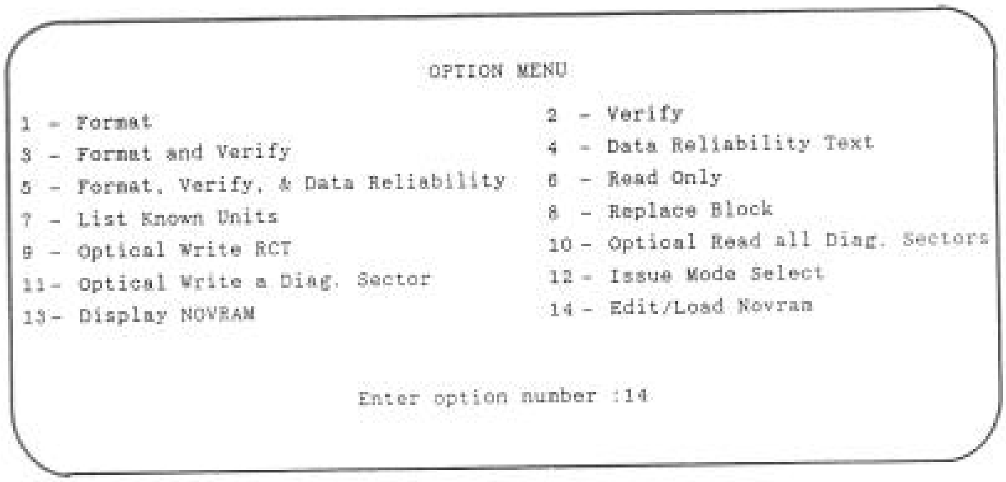
The following subsections define each of the available options, their function, and the situations to which they apply. The following subsections are presented in the order that they will most commonly be used. This might not correspond to the order listed in the menu.

Not all the options listed above in the main menu are supported on all device types used with the UC07/08. In these cases, depending on the type of device, Disk F.R.D. returns an "option not supported" message when an unsupported operation is attempted. Unsupported operations are noted in subsequent paragraphs.

The main menu and each submenu will prompt you for required input. When you enter a valid selection, Disk F.R.D. will either perform the selected operation or display the next menu. If you make an invalid entry, Disk F.R.D. rejects it and reprompts you.

Based on the nature of the MSCP emulation being performed, some operations might produce an observable delay when performed on previously unformatted drives. This delay is approximately 30 seconds.

When an option is finished, Disk F.R.D. displays the prompt "Hit any key to continue" and waits for you to do so before returning to the main menu. The menu appears as follows:



```
                              OPTION MENU

1 - Format                                   2  - Verify
3 - Format and Verify                        4  - Data Reliability Text
5 - Format, Verify, & Data Reliability       6  - Read Only
7 - List Known Units                         8  - Replace Block
9 - Optical Write RCT                        10 - Optical Read all Diag. Sectors
11- Optical Write a Diag. Sector             12 - Issue Mode Select
13- Display NOVRAM                           14 - Edit/Load Novram


                       Enter option number :14
```

Figure 5–1. Sample Tape F.R.D. Test Selection Menu

The option descriptions that follow are ordered according to logical use. If you need to reference an option quickly, check the Table of Contents.

5.5.1 Option 14 – Edit or Load NOVRAM

The UC07/08 Host Adapter uses an onboard NOVRAM to store the subsystem configuration and device geometry information it needs to control the disk drives attached to its SCSI bus.

Before you can begin to use the other Disk F.R.D. options to prepare or test your disk subsystem, your UC07/08 must have the subsystem configuration data loaded in its NOVRAM. This information can be loaded into the NOVRAM using one of the three following methods:

1. **Emulex Automatic Setup of UC07 (suggested method)**

When you select Option 14, you are prompted with a question, "**Emulex Automatic Setup of UC07? [Y or N, def = N]**" If you answer "Y", F.R.D. displays a message asking you to make sure that all attached devices are powered on and ready.

Enter a <Carriage Return>. The UC07/08 then uses SCSI TEST UNIT READY, INQUIRY and other SCSI commands to determine the address and other pertinent information about each attached device.

Information stored in NOVRAM includes drive geometry, SCSI ID, and LUNs for all devices attached to that SCSI ID. Only devices that identify themselves as Random Access Magnetic disk devices cause parameters to be loaded in the NOVRAM. In addition, autoconfigure displays information about the vendor identification, the product identification, and the revision level information returned by the INQUIRY command of any disk.

Several restrictions must be observed when using automatic setup:

- The device must be CCS compatible.
- The device must identify itself as either a Host Adapter (Initiator), Random Access Magnetic Disk, Compact Disk, or WORM (optical) device.
- Autoconfigure cannot resolve SCSI ID conflicts. Before starting autoconfigure, ensure each SCSI device on the bus has a unique SCSI address. (The UC07/08 will default to SCSI address 7. If you have more than one UC07/08 on the SCSI bus, you must change the address to avoid conflicts.)

Failure to observe these restrictions might result in failure of the automatic setup feature (No devices shown), or cause the SCSI bus to hang.

Emulex Automatic Setup Mode

The revision M firmware adds Emulex automatic setup mode. This feature allows faster NOVRAM and controller default setups with maximum disk capacity. Emulex recommends this mode for all new installations. In existing installations in which NOVRAM was previously setup without this feature, be aware of some compatibility issues. If you add this feature on drives previously formatted without Emulex automatic setup, it is mandatory to first backup the data to a reliable source, then change the NOVRAM to Emulex automatic setup mode, and reformat all the attached drives. This ensures that you receive the maximum storage capacity without losing any data integrity.

The Emulex automatic setup stores all the controller and drive parameters into NOVRAM for you and provides a quick, reliable method of setting up the controller that enables maximum performance and capacity. This method uses the disk drive manufacture's defaults (not the saved parameters) for disk geometry and spare block requirements. It also enables a transparent replacement mode that reserves one spare track per spindle and provides an area on the disk for block replacements. Data preserved in this spare track is protected against power fails during replace operations. The drive will not retain any spare cylinders for diagnostic testing and, therefore, will destroy data on the drive if you run diagnostics (unless you read only). If you wish to use the absolute maximum capacity of the drive, edit NOVRAM and answer "N" to the question **"Enable Transparent Replacements?"** However, when transparent replacements is not enabled, the controller does not automatically replace soft errors.

To eliminate any confusion regarding disk sizes or configurations, Emulex recommends using automatic setup mode to configure NOVRAM. Refer to options listed in this manual for more information on compatibility or special drive requirements. For additional help contact Emulex Technical Support.

2. Autoconfigure

If you answer "N" to the Emulex automatic setup question, you are prompted with a question, **"Do you want to Autoconfigure Host Adapter and SCSI bus? [Y or N, def = N]"** If you answer "Y", F.R.D. displays a message asking you to make sure that all attached devices are powered on and ready.

Enter a <Carriage Return>. The UC07/08 then uses SCSI TEST UNIT READY, INQUIRY and other SCSI commands to determine the address and other pertinent information about each attached device.

Information stored in NOVRAM includes drive geometry, SCSI ID, and LUNs for all devices attached to that SCSI ID. Only devices that identify themselves as Random Access Magnetic disk devices cause parameters to be loaded in the NOVRAM. In addition, Autoconfigure displays information about the vendor identification, the product identification, and the revision level information returned by the INQUIRY command of any disk.

The same restrictions that apply to Emulex automatic setup mode must be observed when using Autoconfigure.

Failure to observe these restrictions might result in failure of the Autoconfigure feature (No devices shown), or cause the SCSI bus to hang.

After Autoconfigure is finished, the UC07/08 NOVRAM will contain information about SCSI ID, LUNs, and drive geometry as default values. Disk F.R.D. will continue with the rest of the Load/Edit NOVRAM option menu. You will be prompted to load any NOVRAM values not obtainable by Autoconfigure such as DMA Burst Length, MSCP Replacements, etc. When you are prompted for information about autoconfigure-loaded parameters, you can either accept the default value as loaded by Autoconfigure or change it.

Disk F.R.D. prompts you to choose one of four different device type of codes. Once a drive is chosen, the rest the of Disk F.R.D. menu will ask questions appropriate to that device type.

If you specify a type code other than 4 (Autosize), F.R.D. asks if you want to alter device geometry. If the answer is "N", you will not be prompted for information about device geometry. If you answer "Y", each question about drive geometry will be prefaced by a comment that indicates the drive geometry might not be changeable; in these cases, the device default will be used.

If you choose type code 4 (Autosize), you will not be prompted for any information concerning device geometry. The UC07/08 will obtain that information from the device each time the device is brought online. This allows the user to freely exchange drives of different sizes without changing the NOVRAM.

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When you select Option 14, you are prompted with the question, **"Do you want to Auto-configure the SCSI bus"?** If you answer "N", you are then prompted for NOVRAM information. You must know the SCSI ID and LUN information for each device you intend to configure. In addition, unless you choose type code 4, you will be asked to supply device geometry information for each device you configure.

If you specify a type code other than 4 (Autosize), F.R.D. asks if you want to alter device geometry. If the answer is "N", you will not be prompted for information about device geometry. If you answer "Y", each question about drive geometry will be prefaced by a comment that indicates the drive geometry might not be changeable; in these cases, the device default will be used.

NOTE: The default value, which appears with the range of values for each option, is indeterminate and indicates only the current value. This value might or might not be the value that your installation requires.

5.5.1.1 DMA Threshold

This parameter sets the DMA threshold value. The UC07/08 uses this value to determine how many words into a DMA burst it will wait before checking to see if another device on the Q-Bus has set DMR. The valid range is from 1 through 8. The higher you set this value, the less often the UC07/08 will relinquish bus mastership to other devices. In MicroVAX systems, this parameter is important because the CPU sets DMR whenever it wants to service an Q-Bus bus interrupt. In MicroVAX systems with a large number of interactive terminal users, the frequency of Q-Bus bus interrupts can be quite high. In this type of application, if you set the DMA threshold too low, the effect is to increase the length of time it takes for disk applications to be completed. If you set the DMA threshold too high, it might affect the apparent user terminal response time. We recommend setting this value to eight, then decreasing it only if terminal response or data late problems on other devices occur.

5.5.1.2 DMA Burst Delay

This parameter sets the value of time in microseconds that the UC07/08 waits to raise DMR between DMA bursts. The valid range is 2 through 32, in multiples of 2. The suggested value is 4.

On LSI-11 systems, where the system memory resides directly on the LSI-11 bus, we recommend using a minimum value of 4. This is the value specified by the LSI-11 Bus Handbook.

On MicroVAX systems or LSI-11 systems (LSI-11/83) where the system memory resides on a private memory bus, this value can be set to the minimum of 2 for maximum disk DMA performance.

Keep in mind that the lower you set this value, the less opportunity other devices will have to get their DMA requests honored. This is particularly true if the UC07/08 is on the front of the bus. If you have a lightly-loaded system with a limited number of users and disk speed is the important consideration, set this value to the minimums defined above. If you add interactive users and devices to the system, you might need to increase the value of this parameter to maintain a balance among disk throughput, terminal response, and DMA needs of other devices on the bus.

5.5.1.3 Host Adapter SCSI Address

This parameter sets the SCSI address of the UC07/08. The valid range is from 0 through 7, and the suggested value is 7. *If you have more than one UC07/08 connected to the same SCSI bus, you must change this value to avoid conflicts.*

5.5.1.4 Enable SCSI Parity Checking

This parameter enables or disables SCSI parity checking. A yes response enables parity checking, while a no response disables parity checking. Before enabling this option, ensure that the SCSI device you are connecting supports parity.

5.5.1.5 Enable ESP Chip Slow Cable Mode

This parameter enables or disables the ESP IC's slow cable feature. A "Yes" response enables the slow cable mode, while a no response disables the mode.

This feature might need to be enabled in systems where unshielded cables of maximum SCSI bus length are used in noisy environments. The Emulex SCSI Processor (ESP) IC used on the UC07/08 is a very high-speed device. Because of this speed, it is possible for the IC to react to a short duration noise pulse, which might be ignored by slower or lower performance SCSI chips. When the slow cable mode is enabled, the ESP chip requires longer signal durations on these critical signals, thereby acting as a noise filter. We recommend using shielded SCSI cables and minimizing cable lengths, to eliminate the need for slow cable mode.

If you must use unshielded maximum length cables, we recommend that you enable slow cable mode. Except in the case of very high-speed synchronous disk drives, this use of slow cable mode will have no adverse effect on system performance.

5.5.1.6 Unit Offset or Autoboot Unit Number

The Unit Offset or Autoboot Unit Number parameter functions differently, depending on whether the UC07/08 is at the standard base address, or at an alternate base address. The valid range for this parameter is from 0 through 15.

The following two subsections (Autoboot Unit Number and Unit Offset) respectively describe the operation of the UC07/08 at the standard base address, and at an alternate base address.

5.5.1.6.1 Autoboot Unit Number

When the UC07/08 is at the standard base address, the automatic bootstrapping option causes the system to boot automatically from the selected logical unit (0 through 7) on power-up. This option is enabled whenever the UC07/08 is set to the standard base address. This option cannot be used with a MicroVAX or in a system that uses an 11/73B CPU module. When automatic bootstrapping is enabled, the Unit Offset or Autoboot Unit Number parameter selects the autoboot logical unit.

The automatic bootstrapping process requires that the LSI-11 CPU module be configured for power-up mode 0. The following table lists the configuration settings for several popular LSI-11 CPUs.

CPU	Configuration Setting
11/73A	Install W3 and W7
11/23 +	Remove J18–J19 and J18–J17
11/23	Remove W5 and W6
11/02	Remove W5 and W6

If you are using automatic bootstrapping, the controller will wait indefinitely for the boot device to come online and ready.

If your UC07/08 is installed at an alternate LSI-11 bus address, you can still bootstrap from a drive supported by the UC07/08, by using any boot process other than autoboot.

5.5.1.6.2 Unit Offset

If the UC07/08 is installed as a second MSCP controller at an alternate address, the **Unit Offset or Autoboot Unit Number** parameter has a different function. Some operating systems require that no two MSCP drives have the same MSCP Unit number, even though the units may be attached to different controllers at different CSR addresses.

This parameter allows you to specify the MSCP Unit number of the first drive on the UC07/08 when your UC07/08 is being installed as a second MSCP controller (at an alternate LSI-11 bus address). You may specify a unit number that is contiguous with the highest unit number on the MSCP controller at the primary LSI-11 bus address, or you may leave a gap.

5.5.1.7 Type Code

Each SCSI target device attached to the host adapters SCSI bus must be defined in the NOVRAM by a type code. A maximum of 7 SCSI target devices can be attached to each SCSI bus. SCSI initiator devices on the bus are not identified in the NOVRAM; however, the total number of SCSI devices including targets and initiators cannot exceed 8. The UC07/08 recognizes four different type codes (Type Code 1 through Type Code 4) for SCSI target devices. Autoconfigure will assign a default value for type code as determined by information returned from the device during Autoconfigure.

For each SCSI target device that you define, Disk F.R.D. will prompt you for the remaining configuration parameters. The type code you specify for each target device determines which configuration parameters are required. The type codes are as follows:

TYPE CODE 1 (ST506 Device)

A type code of 1 indicates that the SCSI target device being configured is a SCSI/ST506 device (for example, an Emulex MD01).

TYPE CODE 2 (ESDI Device)

A type code of 2 indicates that the SCSI target device being configured is a SCSI/ESDI device (for example, an Emulex MD21, MD23, or MD25, or a disk drive with an embedded SCSI controller).

TYPE CODE 3 (Optical Device)

A type code of 3 indicates that the SCSI target device being configured is a WORM (Write Once Read Many) optical drive or a Magneto-Optical drive. After you specify type code 3, you will be asked to specify the device. If the device is a Magneto-Optical device, enter "Y". If the device is a WORM device, enter "N".

TYPE CODE 4 (Autosize Device)

A type code of 4 indicates that the SCSI target device being configured is any one of the three previous types, and that the physical configuration is to be defined by data received from the target device. The purpose of Type Code 4 is to allow the target device parameters to change, without having to reconfigure the device parameters in the NOVRAM each time a new device is attached. This feature is particularly useful in systems using a removable Winchester drive, such as the Emulex ER2/S.

In order to use Type Code 4, the target device must support the following SCSI commands:

- INQUIRY (12H)
- MODE SENSE (1AH)
- READ CAPACITY (25H) CAUTION

CAUTION! If Type Code 4 is used to autosize optical disks, disk packs written with the Emulex UC04 Host Adapter will NOT be format compatible with the UC07/08. See Appendix C for UC04 compatibility data.

A number of factors must be taken into account when using Type Code 4. The values returned and the source of these values varies from device to device and vendor to vendor. Because of the wide variety of device types and device vendors' products that can be attached to the UC07/08, it is beyond the scope of this manual to identify the method used by a specific vendor or device type. In general, the following methods are widely used today:

1. Physical geometry, option configuration, and other device-dependent information is written on the device media at format time. The actual values used might come from default parameters supplied by the device controller itself, or from values supplied by the host adapter that was attached to the device at the time that the device was formatted.
2. Physical geometry, option configuration, and other device-dependent information is supplied by the device controller based on jumper and switch settings on the device controller or coded in the device controller's firmware.

Because of these inconsistencies, the UC07/UC08 uses the following methods to define drive size when Type Code 4 is selected.

Format Operation

When the UC07/UC08 performs a format operation, it will first perform a mode sense with the Return Default Values bit set. The information returned will be used to issue a mode select followed by a format command. This means that any parameter saved on the disk will be destroyed, and the drive will be formatted to its default size.

Normal Operation

Except when formatting, the UC07/UC08 uses a MODE SENSE with the SAVED bit set to size the drive.

NOTE: If you use the list option to display the drive size on a previously unformatted or non-UC07/UC08 formatted drive, the drive size and the contents of the NOVRAM will be incorrect.

5.5.1.8 Block Size

This parameter specifies the size of a logical block, in bytes, on the optical drive. The acceptable values are 0 for a block size of 512 bytes, or 1 for a block size of 1024 bytes. Disk F.R.D. will request this parameter only for Type Code 3.

5.5.1.9 Number of Blocks per Track

This parameter specifies the number of blocks per track. The valid range is from 1 through 255. Disk F.R.D. will request this parameter only for Type Code 3.

5.5.1.10 Size of Drive in Blocks

This parameter specifies the size of the optical drive in blocks. The valid range is from 200 through 4,294,967,295. Disk F.R.D. will request this parameter only for Type Code 3.

5.5.1.11 Total Number of Physical Sectors per Track

This parameter specifies the total number of physical sectors per track, including spares. The valid range is from 1 through 255. Disk F.R.D. will request this parameter only for Type Codes 1 and 2.

5.5.1.12 Total Number of Physical Heads

This parameter specifies the total number of physical data heads per physical drive. The valid range is from 1 through 63. Disk F.R.D. will request this parameter only for Type Codes 1 and 2.

5.5.1.13 Total Number of Physical Cylinders

This parameter specifies the total number of physical cylinders per physical drive, including spares. The valid range is from 1 through 4095. Disk F.R.D. will request this parameter only for Type Codes 1 and 2.

5.5.1.14 Number of Spare Sectors per Track

This parameter specifies the number of spare sectors to reserve per track. The valid range is 0 through 3. If 0 is specified, no spare sectors are reserved. Disk F.R.D. will request this parameter only for Type Codes 1, 2, and 4. The suggested value is 1.

5.5.1.15 Number of Alternate/Spare Cylinders

This parameter specifies the number of spare cylinders per physical drive. The valid range is from 2 through 250. At least two cylinders must be specified as alternates, as the sector replacement algorithm needs tracks for working space. The suggested minimum value is 2.

Disk F.R.D. will request this parameter only for Type Codes 1, 2, and 4. If there are no spare sectors, Disk F.R.D. will not request this parameter.

5.5.1.15.1 Full Capacity Mode

Full capacity mode disables any diagnostic cylinders, spare sectors, and tracks that might normally be retained. This mode allows the full capacity of the drive (may require reformatting).

5.5.1.16 Enable MSCP Replacements

This parameter enables or disables MSCP replacements. A yes response enables MSCP replacements, while a no response disables MSCP replacements. Disk F.R.D. will request this parameter only for Type Codes 1, 2, and 4. For details about the effect of this option and device requirements, see subsection 5.5.1.30.1.

5.5.1.17 Enable Transparent Replacements

Disk F.R.D. will request this parameter only if the answer to the previous question (enable MSCP replacements) was no, and the Type Code is 1, 2, or 4. This parameter will also be requested for type code 3 devices that you identify as Magneto-Optical. This parameter enables or disables transparent replacements. A yes response enables transparent replacements, while a no response disables transparent replacements. For details about the effect of this option, see subsection 5.5.1.30.1.

5.5.1.18 Ignore FCT Errors

Disk F.R.D. will request this parameter only if transparent replacements are enabled, and the Type Code is 1, 2, or 4. This parameter will also be requested for type code 3 devices that you identify as Magneto-Optical. A yes response to this parameter causes Disk F.R.D. to ignore FCT errors.

This parameter should be set to YES only in case of a malfunction which has caused the FCT area to become corrupt. If this happens, the UC07/08 will not bring the device online, thus making it impossible to access the data on the device. Setting this parameter to YES allows the online function to ignore FCT errors and allows the device to be brought online to retrieve the data. Once the data has been retrieved, this parameter should reset to NO and the device reformatted.

5.5.1.19 Split Drive

This parameter allows the drive defined by this parameter block to be split into two logical disk units. Disk F.R.D. will request this parameter only for Type Codes 1 and 2. A yes response splits the drive.

Use of the split option enables seek ordering and overlapped seek processing in the MSCP Controller, which reduces performance, particularly during times when both logical units of a split physical drive are active. The SCSI target device to which the split drive is attached must have SCSI disconnects disabled. In addition, a format command to EITHER logical unit will reformat the entire drive (BOTH logical units).

5.5.1.20 Starting Block Number for Second Logical Drive

This parameter will be requested only if the answer to the previous question (split drive) was yes. This parameter specifies the starting block number of the second logical drive. If the starting block number entered does not fall on a track boundary, Disk F.R.D. will truncate the value to the next lower track boundary. The valid range is any value between 10 cylinders from the beginning of the drive and 10 cylinders from the end of the drive.

5.5.1.21 Reduced Write Current Cylinder

Disk F.R.D. will request this parameter only for Type Code 1. This parameter specifies the physical cylinder at which the write current to the data heads is reduced. Some drives require that the write current to the heads be reduced above a certain cylinder to reduce the strength of the flux transition. This reduction prevents adjacent flux transitions in the higher cylinders (where they are closer together) from displacing one another to such an extent as to force data bits out of their data clock windows.

The valid range is from 0 through 4095. If no write current reduction is required, specify the total number of physical cylinders.

5.5.1.22 Write Precompensation Cylinder

Disk F.R.D. will request this parameter only for Type Code 1. This parameter specifies the physical cylinder at which the timing of write data transmitted to the disk drive must be advanced or retarded (with reference to the disk data clock). This timing shift compensates for timing shifts that are caused by adjacent flux transitions in the higher cylinders (where they are closer together). Shifting the write data with respect to the data clock ensures that, when the data is read back, the data will fall within the clock window, despite the tendency of one transition to affect the apparent position of the adjacent transition. This shifting is called precompensation.

The valid range is from 0 through 4095. If no write precompensation is required, specify the total number of physical cylinders.

5.5.1.23 Step Code

Disk F.R.D. will request this parameter only for Type Code 1. This parameter specifies the stepping mode of the disk drive. The valid range is from 0 through 65,535. The table below is an example based on the Emulex MD01. For other devices, consult the user manual supplied with the device.

Step Code	Stepping Mode
0	Unbuffered, 3 msec
1	Buffered, 11 usec
2	Buffered, 12 usec

For the MD01, Emulex recommends the fastest buffered step code available (step code of 1). Use a slower buffered step code or the unbuffered step code if your drive requires it.

5.5.1.24 Removable Media

This parameter indicates whether the disk media is fixed or removable. A "Yes" response indicates that the media is removable; a no response indicates fixed media.

5.5.1.25 Disable SCSI Disconnects

This parameter will not be requested if the drive has been configured as a split drive. This parameter disables or enables SCSI disconnects. When enabled, drives performing time-consuming tasks release the SCSI bus temporarily and reconnect when the task is complete; thus, several operations can be performed at once. Timing considerations of unique software applications might dictate that you disable disconnects.

A "Yes" response disables SCSI disconnects, while a no response enables SCSI disconnects.

5.5.1.26 Prevent Manual Spindown

This parameter allows the user to prevent inadvertant spindown of a mounted media. This parameter is particularly important when a WORM optical drive is used because failure to write cached data and device maps to a disk before it is spun down can result in data loss.

A "Yes" response causes the UC07/08 to issue a SCSI Prevent/Allow Media Removal command with the Prevent bit set whenever a device is brought online. This command prevents manual spindown of the drive until a Dismount command is issued by the operating system. When the operating system issues a Dismount command, the UC07/08 issues a SCSI Prevent/Allow Media Removal command with the Prevent bit reset to unlock the drive and allow manual spindown of the drive.

A no response disables the UC07/08 from sending the SCSI Prevent/Allow Media Removal command during Mount and Dismount operations. No is the default setting. Regardless of how this parameter is set, the UC07/08 will issue a SCSI Stop command to the device when a Dismount/Unload command is issued by the operating system.

5.5.1.27 Enable Synchronous Data Transfers

This parameter enables or disables synchronous SCSI data transfers. A "Yes" response enables synchronous data transfers; a no response disables synchronous data transfers. Before enabling this option, be sure that the target device being configured supports synchronous SCSI data transfers.

5.5.1.28 Disable Host Adapter of Polling Drives

During normal operation, the UC07/08 will periodically issue Test Unit Ready commands to determine changes in Power On status of devices on the SCSI bus. This action resets the Attention condition issued by SCSI devices on the first access after a power on. In some cases, where the user has written a SCSI driver that interfaces directly with the device via SCSI commands, for example, Pass Thru SCSI Mode, polling must be disabled to allow the driver to detect and reset this attention condition. A yes response disables polling.

A no response enables normal device polling. When the UC07/08 is used in systems which use a standard MSCP driver this parameter must be enabled (user response = n) to allow proper operating system response to drive Powerup/Powerdown transitions.

5.5.1.29 Defining Addresses for Physical Drives

A SCSI address and SCSI LUN must be defined for every drive in the system. Two values are written for each physical drive: the first value is the SCSI address of the controller and the second value is the drive's SCSI LUN. The value that you select in NOVRAM for each controller's SCSI address must match the corresponding SCSI address selected on the controller. Similarly, the value that you select in NOVRAM for each drive's LUN must match the corresponding LUN value selected on the drive. In addition, no two SCSI devices on any one SCSI bus can have the same SCSI address.

The SCSI controller address range is 0 through 7; the SCSI LUN range is 0 through 7. For each physical unit that you configure, you will be prompted to specify a value for both the SCSI controller address and for the drive LUN. If Autoconfigure was used, the NOVRAM will already be loaded with the correct values for each SCSI device and its attached LUNs.

After you have answered all the configuration questions, F.R.D. will prompt for another unit. If no units remain to be configured, or you have reached the limit of 8 logical unit numbers, F.R.D. will ask if you want to change any parameters before loading the NOVRAM.

```
Do you want to configure another unit [Y or N, def=N]?

Do you want to change any parameters [Y or N, def=N]?

** ALL DATA ON DRIVE CAN BE LOST ** DO YOU WANT TO
LOAD THE NOVRAM [Y or N]?
```

5.5.1.30 Defect Management

The UC07/08 offers the user a choice of three methods to manage defects on magnetic disks. The type of defect management used must be programmed in the NOVRAM for each SCSI target device. The type of defect management scheme you choose depends on your application and the capabilities of the SCSI target device performing the defect management.

5.5.1.30.1 Host-Initiated Bad Block Replacement

Sometimes referred to as MSCP-compatible mode, Host-Initiated Bad Block Replacement is a scheme whereby the host software is responsible for issuing MSCP "replace" commands to initiate block replacement. The conditions under which the host software issues a replace command are dependent upon the host software and the type of error information generated by the UC07/08.

This mode of operation is fully DEC compatible and provides software control of replacements. It even allows blocks with uncorrectable or otherwise inaccessible data to be replaced by using a forced error flagging scheme to mark the replaced block, in such a way as to inform the operating system that only the data in the block is bad, while the block itself is good.

This method also provides power fail protection for those cases where a power fail occurs in the middle of a replacement operation. Various flags are used to indicate what step of the replacement is in progress at all times, so that when power is re-applied, any replacement in process can begin where it left off. We recommend using this mode whenever possible.

To use MSCP replacement, the target device absolutely must support all four of the following:

- A 48-bit ECC that guarantees that any 16-bit data error will be reported as an uncorrectable ECC error.
- SCSI Re-assign, Read Long, and Write Long commands
- The SCSI target device must guarantee that the ECC provided by the UC07/08 during the Write Long operation is not modified in any way by the target device before being written to disk.
- The SCSI target device must guarantee that the ECC written to the disk during the Write Long operation is not modified in any way by any subsequent Read or Read Long operation.

The only SCSI devices that we guarantee to support Host-Initiated Bad Block Replacement are the Emulex MD01, MD21, MD23, and MD25 controllers, and the Emulex ER2/S removable subsystem.

While some SCSI device controllers and embedded drives might support these features, Emulex cannot guarantee proper operation now or in the future.

It is the user's responsibility to contact the vendor of the SCSI device to secure compliance and performance commitments.

This mode is enabled by answering yes to the NOVRAM prompt, "Do you want to enable MSCP replacements?"

5.5.1.30.2 Controller-Initiated Bad Block Replacement

Sometimes referred to as transparent mode, Controller-Initiated Bad Block Replacement is supplied as a best-case alternative to Host-Initiated Bad Block Replacement for those SCSI target devices that do not provide the features required for host-initiated replacement. In this mode, the UC07/08 firmware initiates and controls the replacement operations transparently to the host software. This mode allows blocks with correctable data errors to be replaced via the SCSI re-assign command. The replacement operation is protected during power failure by caching the data and using flags that indicate the progress that has been made on any replace command that was in progress when the power fail occurred. During the replacement operation, a special FCT area on the disk is used to cache replacement data and progress flags.

The principle disadvantage of this method is that since forced error flagging cannot be done, blocks with uncorrectable data errors or inaccessible data fields cannot be replaced dynamically during system operation. In the case of uncorrectable data errors (for example, uncorrectable ECC error, block not found, etc.) the UC07/08 simply reports the fact that an uncorrectable error has occurred. The operating system will then proceed to deal with the error much as it would deal with a "Forced Error". Blocks with uncorrectable data errors can only be replaced by using the replace block operation of Disk F.R.D.

Blocks with correctable or soft data errors are replaced dynamically by the controller before they become uncorrectable. For these replacements to occur, the SCSI target device must support the SCSI re-assign commands and must report the fact that a correctable error has occurred. Correctable errors can include ECC- correctable data errors or retry-corrected header operations. If the target device simply sends corrected data or retries the operation until it is successful, but does not report the error to the UC07/08, no replacements will occur.

Correctable errors will be reported to the operating system via the MSCP error log packets, to enable the operating system to be aware that replacements have in fact taken place. This allows the user to monitor the status of a particular drive.

This mode is enabled by answering no to the NOVRAM prompt, **"Do you want to enable MSCP replacements?"** and yes to the NOVRAM prompt, **"Do you want to enable transparent replacements?"**

5.5.1.30.3 Non-Block-Replaceable Device Mode

The non-block-replaceable device mode must be used if the SCSI target device does not support the SCSI reassign command, or if the target device is an optical device. This mode completely precludes dynamic block replacement of any kind while operating the system.

All errors, correctable or uncorrectable, will be reported to the system via MSCP errlog messages. This mode of operation should only be used with devices that provide very sophisticated error recovery schemes that preclude the occurrence of reported errors (for example, optical devices).

This mode is enabled by answering no to the NOVRAM prompt, **"Do you want to enable MSCP replacements?"** and no to the NOVRAM prompt, **"Do you want to enable transparent replacements?"**

NOTE: All of the following options are designed to be run on multiple drives. Prior to starting each option you will be prompted for a device number to test. Device numbers can be entered in any sequence. To terminate the drive number prompt, enter a <CR>. All operations except Reliability are performed on a single drive at a time. Any drive which fails is dropped and testing moves to the next drive in the string. The Reliability tests are run on all specified devices simultaneously.

5.5.2 Option 1 – Format

The Format option initially formats a magnetic disk drive. The operation writes sector headers and initializes the drive's RCT tables. It is used to format a virgin drive, a drive that has been determined to contain unusable data, or a drive with a format that is improper to use with a particular controller.

After formatting, the drive contains a valid RCT with a serial number you specified.

The SCSI Device Controller performs the actual format operation in response to a SCSI format command with the "Complete List" and "Format Data" bits set. The Defect List sent will indicate no defects.

Depending on the SCSI device controller used, the format operation might also replace defective blocks contained in the Manufacturer's Defect List (MDL), perform a Read after Write pass with worst case data patterns and replace any blocks with errors, or any other tests to find and replace defective blocks. The following subsections are a list of actions performed by Emulex SCSI bridge controllers during formatting.

CAUTION! When Option 1 (Format) is used, BOTH logical units on a split drive WILL BE FORMATTED. When formatting a split drive, YOU MUST SPECIFY BOTH UNITS WHEN ASKED FOR DEVICE NUMBERS TO TEST.

5.5.2.1 Emulex MD01 (SCSI/ST506)

When the format command is received, the MD01 will format the entire unit using the geometry information sent from the UC07/08 via the Mode Select Command. After the format completes, each block on the drive is read. Any block that produces an error during the read operation is replaced.

5.5.2.2 Emulex MD21, MD23, and MD25 (SCSI/ESDI)

When the format command is received, the MD21, MD23 and MD25 will format the entire unit using the geometry information sent from the UC07/08 via the mode select command. Any blocks listed in the drive's MDL will be replaced during the format operation. Blocks listed in the Grown Defect List (GDL) are not replaced during format. This is done purposefully to prevent blocks which may have been erroneously replaced in the event of a system malfunction. Because the MD21, MD23 and MD25 controllers replace all blocks listed in the MDL, they do not use the read pass performed by the MD01 controller.

When the mode select command containing the drive geometry information is received, the MD21, MD23 or MD25 checks the value supplied for the number of sectors per track. If the drive being formatted is in hard sector mode and there is a difference between the value requested and value returned by the drive, the Mode Select Command will be rejected by the MD21, MD23 or MD25. Disk F.R.D. will print a warning message:

```
MODE SELECT COMMAND FAILED FORMATTING WITH DRIVE DEFAULT PARAMETERS
```

The format will continue to normal completion. The consequence of this message is that the value returned for user size might not be accurate. This can be corrected either by reloading the NOVRAM with the correct value for the number of sectors per track, or by setting the NOVRAM to autoconfigure the device.

5.5.2.3 Non-Emulex SCSI Devices

In general, most SCSI devices on the market today support the Mode Select Command and will follow the same rules that Emulex controllers follow. Keep in mind that the Mode Select is an optional SCSI command. Some devices do not support the Mode Select Command because their geometry is fixed by switch settings, by jumper settings, or by firmware. In this case, the Mode Select Command will fail and Disk F.R.D. will print a warning message. Operation will continue as described for the MD21, MD23 and MD25 controllers. The only way to guarantee that a valid user size is presented to the system is either by setting the NOVRAM to autoconfigure the device, or by ensuring that the geometry values loaded into the NOVRAM match the actual drive geometry.

5.5.2.4 Magneto-Optical Devices

Although Magneto-Optical devices appear to the system as rewritable devices, they have some peculiarities which must be taken into account during format. When the Sony drive is issued a format, the drive actually formats and certifies the pack. The Richo drive does a dummy format which does nothing. In addition the Richo drive reacts like a WORM drive: when it reads an unwritten block, it returns a Blank Check condition. This means that a block must be written before it can be read since a Blank Check is unacceptable on a magnetic device. The UC07/08 fixes this by performing a Single Pattern Write Pass of the entire pack when the Format option is used. This makes all blocks on the disk readable after format, just like a magnetic drive.

5.5.3 Option 2– Verify

The Verify option write- and read-exercises all user-available blocks. Disk F.R.D. uses four worst-case data patterns to find and replace pattern-sensitive blocks not found in the drive defect list. It asks for the logical unit number (LUN) of the drive to be verified. After you have entered all the LUNs to be verified, Disk F.R.D. will prompt for the number of Write/Read passes.

Verify operations are performed on 32 logical blocks at a time. Logical blocks are referenced by Logical Block Number (LBN).

During verify operations, Disk F.R.D. does not do anything to cause the SCSI target device to diminish its normal error recovery techniques. This means that the ability of Disk F.R.D. to find and replace defective areas on the media depends on the target device reporting that an error condition has occurred. Generally, the lower the level of filtering that the device does, the more efficient the Verify option will be.

When Disk F.R.D. encounters a block that it cannot access because of header or data field errors, Disk F.R.D. displays the LBN in error. Because the failing pattern might not be the first pattern, it is possible that replacement blocks might not be tested with all patterns. For this reason, Emulex recommends running at least two Verify passes over all 4 data patterns.

The verify option also offers a bad block replacement feature which, when enabled, replaces any bad blocks reported by the SCSI target device.

At the end of all testing or when you enter a <Ctrl C>, Disk F.R.D. reports the number of bad blocks detected by the Verify operation. There will be no message if the Verify option does not detect any errors.

5.5.4 Option 3– Format and Verify

The Format and Verify option formats a drive, then tests the surface for defective and pattern-sensitive sectors. It performs both of the operations that are available separately with options 1 (Format) and 2 (Verify). This option also offers a bad block replacement feature which, when enabled, replaces any bad blocks found during the verify operation.

5.5.5 Option 4– Data Reliability Test

The Data Reliability Test option thoroughly tests the disk subsystem. The reliability test uses Write, Write/Check, and Read functions to test the controller-to-drive portion of the subsystem. In addition, an independent DMA operation between the host memory and the controller tests the host-to-controller interface.

The test defaults to two reserved diagnostic cylinders so that user data will be protected; a test of the full pack is your option. To run the reliability test indefinitely, select 0 (zero) passes.

If the test encounters errors, Disk F.R.D. displays text error messages. These messages are primarily for use by Emulex technical support personnel.

CAUTION! If you selected full capacity mode in NOVRAM, data reliability can only be run on the entire disk surface as no diagnostic cylinders are available. This will destroy any usable data that is on the drive.

Full capacity mode disables any spare sectors and tracks that might normally be retained. This mode allows the full use of the drive (may require reformatting) and also disables the diagnostic cylinders.

5.5.6 Option 5 – Format, Verify, and Reliability Test

The Format, Verify, and Reliability Test option combines Options 1 (Format), 2 (Verify), and 4 (Data Reliability Test). This option automates the initialization and testing of drives, since you can select multiple drives and activate the data reliability test without having to wait for the format and verify options to complete. The format and verify portions of this option run in the order of the drives selected. Drives with hard faults are dropped and the sequence moves to the next drive in the list. The reliability portion of this option runs simultaneously on all selected drives.

5.5.7 Option 6 – Read-Only Test

The Read-Only Test option causes all the user-available blocks on the selected drive to be Read-only, not Read/Write, during the Verify pass. When a block is encountered that cannot be accessed because of header or data field errors, Disk F.R.D. displays the Logical Block Number.

The Read-Only Test option also offers a bad block replacement feature that, when enabled, replaces any bad blocks. Because Disk F.R.D. does not cache any read data, no corrected data is available to put in the replacement block. This means that even though the defective block is replaced and no forced error flag is set in the replacement sector, the data is nonvalid.

CAUTION! This might cause problems if the replaced blocks contain executable program files. For this reason, you should back up sensitive data before running the Read-Only Test option with the replacement feature enabled.

The Read-Only Test option can be used only if the drive is formatted.

5.5.8 Option 7 – List Known Units

The List Known Units option lists all the drives that are configured in the NOVRAM. Only those units that the controller can select are listed as available.

A user size (512-byte blocks) is listed with all drives found by this option. The user size does not include RCT area, diagnostic cylinders, designated or hidden spare tracks or blocks, etc.

NOTE: When creating partitions under ULTRIX, be sure a partition does not extend past the user area into the RCT or diagnostic area. Like all MSCP devices, the UC07/UC08 depends on the host software to control accesses to the RCT and diagnostic area of the disk. Failure to observe the user size limitation may corrupt the disk and render it unusable without reformatting.

The user size reported by this option is calculated from geometry data contained in the NOVRAM for either Type Code 1 or Type Code 2. When Type Code 4 is used to autoconfigure devices, the user size is calculated from geometry information returned by the Mode Sense command.

In order for the reported user size to be accurate, the following two conditions must be met:

5.6 Tape F.R.D.

Tape F.R.D. is a diagnostic utility designed to provide the following functions:

- Load and Edit the configuration data needed by the UC07/08
- Test the functions of the host adapter and tape drive
- Verify the switch settings on the UC07/08 module

Options are selected through menus, which are accessed from the host system console.

NOTE: Configuration options must be loaded into the NOVRAM before the host adapter can be used. Although the NOVRAM is loaded at the factory, its contents might not meet your system requirements.

After you specify the type of terminal and enter a <return>, Tape F.R.D. displays the Tape F.R.D. Main Menu.

5.6.1 Initial Screen

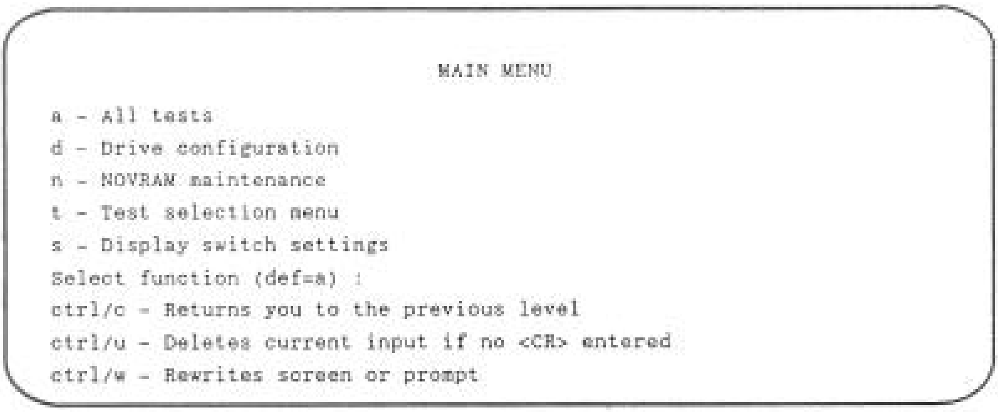
The initial Tape F.F.D. screen shows the revision level of the Tape F.R.D. firmware being used, the tape drive status, and the CSR address location. Tape F.R.D. prompts you to specify whether you are using a video or hardcopy terminal to run the diagnostics.

NOTE: Video display mode supports only DEC VT100 series video terminals and compatible video terminals. Use Hardcopy mode for all other terminals.

After you specify the type of terminal and enter a <return>, Tape F.R.D. displays the Tape F.R.D. Main Menu.

5.6.2 Tape F.R.D. Main Menu

Figure 5-2 shows the Tape F.R.D. Main Menu as it appears on a video display terminal. This menu presents choices for running tape diagnostic tests, configuring the subsystem for tape drive characteristics, and for displaying the switch settings.



```
                              MAIN MENU

a - All tests
d - Drive configuration
n - NOVRAM maintenance
t - Test selection menu
s - Display switch settings
Select function (def=a) :
ctrl/c - Returns you to the previous level
ctrl/u - Deletes current input if no <CR> entered
ctrl/w - Rewrites screen or prompt
```

Figure 5-2. Tape F.R.D. Main Menu

NOTE: On initial power up, some drives (i.e., Exabyte) might be unaccessible on the SCSI bus for up to 120 seconds while running self-tests. Because of this, the drive status that Tape F.R.D. returns can vary, depending on the state of the drive when Tape F.R.D. was started. The drive status can be any of the following:

- Unit not there
- Unit offline or not ready
- Unit online

To make a selection from the Main Menu, type the letter of the selection you want and follow it with a <return>. The choices are:

A – **All tests.** All onboard firmware installation diagnostic tests are executed and any errors reported. This is a basic reliability test.

D – Drive configuration. This option is used to specify the SCSI address and LUN of all attached drives. You can also load the address even if no drive is attached. This allows you to add drives later without running F.R.D. When this option is selected, the current drive configuration is displayed. The default value displayed is the current value.

You are then asked if you want to modify the configuration. If you answer "N", the control is returned to the Main Menu.

```
Number of drives to configure (1-7,def=2 dec):
Drive #1 i.d. (0-7,def=1 dec):
Drive #1 Lun number (0-7,def=0 dec):
Drive #2 i.d. (0-7,def=0 dec):
Drive #2 Lun number (0-7,def=0 dec):


Modify? (y/n,def=n):
```

Figure 5-3. Drive Configuration Menu

A SCSI address and SCSI LUN must be defined for every drive in the system. Two values are written for each physical drive: the first value is the SCSI address of the controller and the second value is the drive's SCSI LUN. The value that you select in NOVRAM for each controller's SCSI address must match the corresponding SCSI address selected on the controller. Similarly, the value that you select in NOVRAM for each drive's LUN must match the corresponding LUN value selected on the drive. In addition, no two SCSI devices on any one SCSI bus can have the same SCSI address.

The SCSI controller address range is 0 through 7; the SCSI LUN range is 0 through 7. For each physical unit that you configure, you will be prompted to specify a value for both the SCSI controller address and for the drive LUN.

N – NOVRAM maintenance. Current configuration values are displayed and any errors are reported. You can make changes to the NOVRAM through this option.

T – Test selection menu. This option lets you selectively run any of the six onboard diagnostic tests. A loop count selection lets you determine how many times the tests are run.

S – Display switch settings. The switchpack ON/OFF settings are portrayed on this screen to verify that the firmware has interpreted your settings correctly. The specific configuration options represented by the switch settings are also identified.

5.6.2.1 All Tests

This option performs the following tests, in sequence: BOT and rewind test, write/read test, filemark test, space forward/reverse test, positioning test, and host memory DMA test.

Your response to the loop count prompt determines the number of passes of the test loop. A value of 0 causes the test sequence to continue until halted with a <ctrl/c>.

5.6.2.2 NOVRAM Maintenance

This function lets you specify the UC07/08's configuration options. When selected, the NOVRAM's current data is displayed on the terminal. You will see the NOVRAM parameter descriptor, followed by the range of values in parentheses.

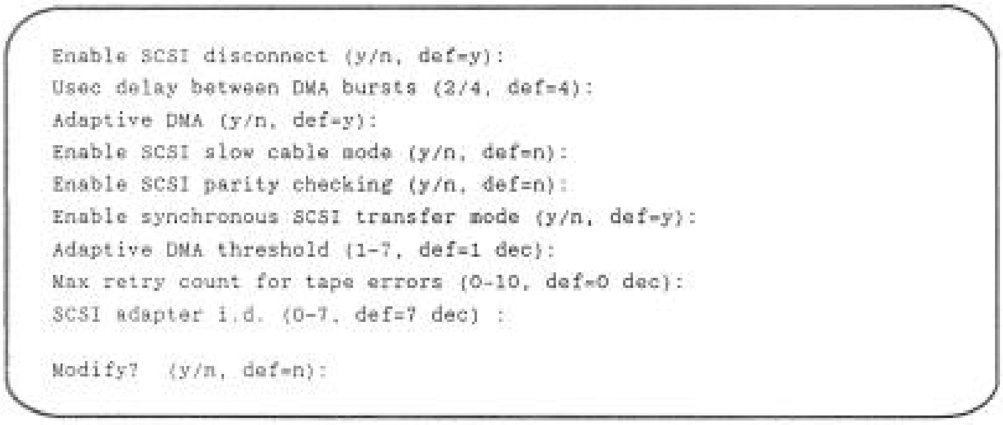
The NOVRAM menu for the TMSCP emulation is shown in Figure 5–4.

NOTE: The default value, which appears with the range of values for each option, is indeterminate and indicates only the current value. This value might or might not be the value that your installation requires.

If the NOVRAM maintenance function fails, it could be because of corrupted or unprogrammed NOVRAM. In this case, an error message will be printed and you are permitted to continue the operation.

You will then be asked if you want to modify the NOVRAM.

If you answer "N", control is returned to the Main Menu.



```
Enable SCSI disconnect (y/n, def=y):
Usec delay between DMA bursts (2/4, def=4):
Adaptive DMA (y/n, def=y):
Enable SCSI slow cable mode (y/n, def=n):
Enable SCSI parity checking (y/n, def=n):
Enable synchronous SCSI transfer mode (y/n, def=y):
Adaptive DMA threshold (1-7, def=1 dec):
Max retry count for tape errors (0-10, def=0 dec):
SCSI adapter i.d. (0-7, def=7 dec) :

Modify?  (y/n, def=n):
```

Figure 5–4. Sample TMSCP NOVRAM Maintenance Menu

If you answer "Y", the cursor moves to the first data field to be modified and you can make changes.

At a hardcopy terminal, the descriptors will be output and the cursor will be positioned at the end of the prompt.

If you enter a CTRL/Z or CTRL/C, control returns to the main menu and the NOVRAM will not be written.

Menu selections are described below.

Options:

- **Enable SCSI disconnect.** This parameter disables or enables SCSI disconnects. When enabled, drives performing time-consuming tasks release the SCSI bus temporarily and reconnect when the task is complete; thus, several operations can be performed at once. Timing considerations of unique software applications might dictate that you disable disconnects.

  A yes response enables SCSI disconnects, while a no response disables SCSI disconnects.

- **Usec delay between DMA bursts.** This parameter sets the value of time in microseconds that the UC07/08 waits to raise DMR between DMA bursts. The valid values are either 2 or 4.

  On LSI-11 systems, where the system memory resides directly on the LSI-11 bus, we recommend using a minimum value of 4. This is the value specified by the LSI-11 Bus Handbook.

  On MicroVAX systems or LSI-11 systems (LSI-11/83) where the system memory resides on a private memory bus, this value can be set to the minimum of 2 for maximum disk DMA performance.

- **Adaptive DMA.** This parameter enables or disables the UC07/08's adaptive DMA mode. Enabling this option ensures that CPU or other device functions are not locked out for excessive periods of time, by allowing the UC07/08, while in the middle of a Block Mode DMA transfer, to release the bus to another device. When disabled, the UC07/08 will seize the bus for the entire DMA burst count.

  A yes response enables adaptive DMA, while a no response disables the mode.

- **Enable SCSI slow cable mode.** This parameter enables or disables the ESP IC's slow cable feature. A yes response enables the slow cable mode, while a no response disables the mode.

  This feature might need to be enabled in systems where unshielded cables of maximum SCSI bus length are used in noisy environments. The Emulex SCSI Processor (ESP) IC used on the UC07/08 is a very high speed device. Because of this speed, it is possible for the IC to react to a short duration noise pulse, which might be ignored by slower or lower performance SCSI chips. When the slow cable mode is enabled, the ESP chip requires longer signal durations on these critical signals, thereby acting as a noise filter. We recommend using shielded SCSI cables and minimizing cable lengths, to eliminate the need for slow cable mode.

  If you must use unshielded maximum length cables, we recommend that you enable slow cable mode. Except in the case of very high-speed synchronous disk drives, this use of slow cable mode will have no adverse effect on system performance.

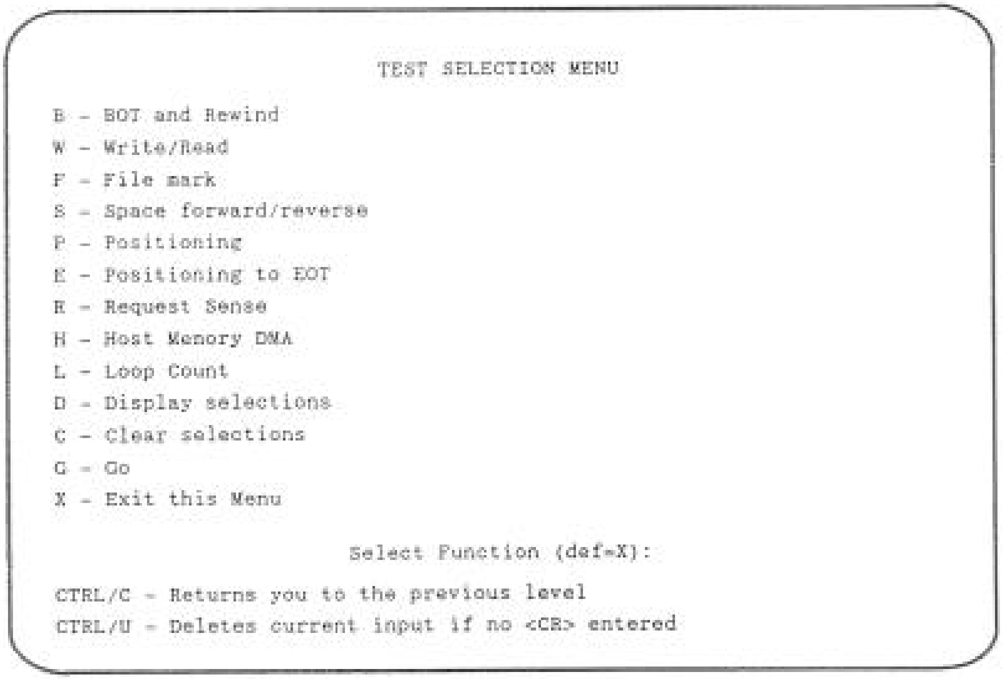
- **Enable SCSI parity checking.** This parameter enables or disables SCSI parity checking. A yes response enables parity checking, while a no response disables parity checking. Before enabling this option, ensure that the SCSI device you are connecting supports parity.
- **Enable synchronous SCSI transfer mode.** This parameter enables or disables synchronous SCSI transfer mode. A yes response enables synchronous SCSI data transfers; a no response disables the mode. Make sure the target device being configured supports synchronous transfers before enabling this mode.
- **Adaptive DMA threshold.** This parameter sets the DMA threshold value. The UC07/08 uses this value to determine how many words into a DMA burst it will wait before checking to see if another device on the LSI-11 bus has set DMR. The range is 1 through 7.

The higher you set this value, the less often the UC07/08 will relinquish bus mastership to other devices. In MicroVAX systems, this parameter is important because the CPU sets DMR whenever it wants to service an LSI-11 bus interrupt. In MicroVAX systems with a large number of interactive terminal users, the frequency of LSI-11 bus interrupts can be quite high. In this type of application, if you set the DMA threshold too low, the effect is to increase the length of time it takes for tape applications to complete. If you set the DMA threshold too high, it might affect the apparent user terminal response time. We recommend setting this value over decreasing it only if terminal response or data late problems on other devices occur.

- **Max retry count for tape errors.** This parameter defines the number of retry operations that the controller will try before reporting an error. This is not a software parameter and will not affect software retries. Lowering the retry count will reduce the time required to initialize a tape, especially for tri-density drives. The range is 0 through 10. For an Exabyte drive, we recommend a value of 0, since this device does its own retries.
- **SCSI adapter i.d.** This parameter sets the SCSI address of the UC07/08 host adapter. The valid range is from 0 through 7.

5.6.2.3 Test Selection

This option permits you to selectively run any of the six tests by means of a menu. Type the letter of the test, followed by a <return>, at the prompt. Repeat for as many tests as you want, then select "Go" to begin test execution.



```
                         TEST SELECTION MENU

B - BOT and Rewind
W - Write/Read
F - File mark
S - Space forward/reverse
P - Positioning
E - Positioning to EOT
R - Request Sense
H - Host Memory DMA
L - Loop Count
D - Display selections
C - Clear selections
G - Go
X - Exit this Menu

                       Select Function (def=X):

CTRL/C - Returns you to the previous level
CTRL/U - Deletes current input if no <CR> entered
```

Figure 5-5. Sample Tape F.R.D. Test Selection Menu

Six diagnostic tests and their descriptions follow. Other selections deal with displaying and running the tests.

B – BOT and Rewind. The UC07/08 checks for the Beginning of Tape (BOT) status by issuing a write, then a rewind, command.

W – Write/Read. The UC07/08 issues a series of write and read commands and compares the data.

F – Filemark. The UC07/08 writes a filemark, rewinds, spaces forward a record, and checks for the End of File (EOF).

S – Space forward/reverse. In this test, the UC07/08 issues commands to check that the tape drive is properly spacing forward and backward with respect to the EOF mark.

P – Positioning. The UC07/08 issues write, rewind, and space commands to check that the tape drive can position properly.

E – Positioning to EOT. The UC07/08 issues write, rewind, and space commands from BOT to EOT. On a full-length tape, this test could run for over two hours. You can shorten this time by using special low-capacity tape cartridges available from Exabyte.

R – **Request Sense.** This option causes the information returned by the SCSI request sense command to be displayed.

H – **Host Memory DMA.** The UC07/08 uses host memory as a scratch pad to verify that the LSI-11 Bus function is transferring data properly.

L – **Loop Count.** This option lets you determine how many times, from 0 to 255, a given test is executed. Selecting 0 is equivalent to selecting an infinite number of passes. If this option is not used, the default number of executions is 1.

D – **Display selections.** This is a convenience option. Test selection is typically made by selecting (but not executing) the tests you want all at once, then selecting the "Go" option which executes the tests. If you want to see the tests you have selected prior to executing them, Display selections will list them on the screen. You can then either go ahead with test execution or change the tests.

C – **Clear selections.** If you want to cancel the tests you have previously selected but not executed, this option will effectively cancel all selections.

G – **Go.** This option begins test execution. You will be asked for confirmation that you do want to run the tests.

X – **Exit this Menu.** This option returns you to the Main Menu.

Completed tests are followed by a message on the screen confirming the number of passes made and the number, if any, of hard, soft, or device errors.

5.6.2.4 Display Switch Settings

This option shows the switch settings of SW1 and SW4 when using TMSCP on SCSI Port 0 or SW2 and SW3 when using TMSCP on SCSI Port 1. A sample display for SW1 (SW2 for Port 2) follows in Figure 5-6; a sample display for SW4 (SW3 for Port 2) is shown in Figure 5-7.

```
Switch 1/2
OFF     ON
----------
|        |
| [*  ] |     1     UC07/08 Host Adapter Reset Switch, Unreadable
                    Hardware Switch
| [*  ] |     2     Fast File Search
| [*  ] |     3     Enable SCSI Interrupts
| [*  ] |     4     Continue on self test error
|        |
----------
```

Figure 5-6. Sample SW1 or SW2 Switch Setting Display

```
Switch 3/4
OFF     ON
----------
|        |
| [*  ] |     1     \
| [*  ] |     2     Address = 17774500 Oct
| [*  ] |     3     /
| [*  ] |     4     /
| [*  ] |     5     TMSCP
| [*  ] |     6     Unreadable hardware switch
| [*  ] |     7     Not Used
| [*  ] |     8     Not Used
| [*  ] |     9     Not Used
| [*  ] |     10    Not Used
|        |
----------
```

Figure 5-7. Sample SW3 or SW4 Switch Setting Display

5.7 Integration and Operation

5.7.1 Testing and Indicators

There are three light emitting diodes (LEDs) on the UC07/08 PWB. These LEDs are used for both diagnostics and for normal operations.

If switch SW1-1 is OFF, the UC07/08 executes a preliminary test at the following times:

- On power-up
- After a reset condition
- After a bus initialization
- After a write operation to the base address register

The self-test routine consists of two test sequences: preliminary and self-test. The preliminary test sequence exercises the 8031 microprocessor chip and the Emulex SCSI Processor (ESP) chip. When the UC07/08 successfully completes the preliminary test, LED3 illuminates indicating that the UC07/08 is waiting for MSCP or TMSCP initialization.

During MSCP or TMSCP initialization, by host software control, the UC07/08 executes a second self-test that exercises the buffer controller chip, the Host Adapter Controller (HAC) chip and its associated circuitry, the onboard RAM, and the control memory EPROM. If the UC07/08 passes this sequence of its self-test successfully, all three UC07/08 LED indicators are OFF.

If a fatal error is detected either during self-test or while the system is running, all three of the LED indicators are ON (illuminated). If the UC07/08 fails to pass its power-up self-tests, you can select a special diagnostic mode (switch SW1-4 or SW2-4 ON) which causes the LED indicators to display an error code. See Fault Isolation Procedure, in Section 6, TROUBLESHOOTING.

During normal operation, LED1 and LED2 flicker occasionally. These LEDs are used to indicate LSI-11 Bus activity and SCSI activity, respectively.

5.7.2 Operation

There are no operational instructions. The UC07/08 is ready for MSCP or TMSCP initialization as soon as it is powered up.

Section 6
TROUBLESHOOTING

6.1 Overview

This section describes the several diagnostic features with which the UC07/08 Host Adapter is equipped, and outlines fault isolation procedures that use these diagnostic features.

Subsection	Title
6.1	Overview
6.2	Service
6.3	Fault Isolation Procedure
6.4	Power-up Self-diagnostic
6.5	Fatal Error Codes

6.2 Service

Your Emulex UC07/08 Host Adapter has been designed to give years of trouble-free service, and it was thoroughly tested before leaving the factory.

Should one of the fault isolation procedures indicate that the UC07/08 is not working properly, the product must be returned to the factory or to one of Emulex's authorized repair centers for service. Emulex products are not designed to be repaired in the field.

Before returning the product to Emulex, whether the product is under warranty or not, you must contact the factory or the factory's representative for instructions and a Return Materials Authorization (RMA) number.

Do not return a product to EMULEX without authorization. A product or component returned for service without an authorization will be returned to the owner at the owner's expense.

In the continental United States, Alaska, and Hawaii contact:

Emulex Technical Support
3545 Harbor Boulevard
Costa Mesa, CA 92626
(714) 662-5600 TWX (910) 595-2521
Outside California: (800) 854-7112

After 5 p.m. Pacific Time, call (800) 638-7243. When answered, you will be prompted to key in 37115, followed by a # symbol, then a message.

Outside the United States, contact the distributor from whom the subsystem was initially purchased.

To help you efficiently, Emulex or its representative requires certain information about the product and the environment in which it is installed. During installation, you should have made a record of the switch settings on the Configuration Reference Sheet.

After you have contacted Emulex and received an RMA, package the product (preferably using the original packing material) and send it postage paid to the address provided by the Emulex representative. You must also insure the package.

6.3 Fault Isolation Procedure

This fault isolation procedure is provided in flowchart form in Figure 6-1. This procedure is based on standard troubleshooting techniques as well as the self-diagnostics incorporated into the UC07/08. The procedure is designed to be used if the self-test fails or if many errors are flagged by the subsystem during normal operation. (If neither of these events takes place, then it is not necessary to follow these procedures.)

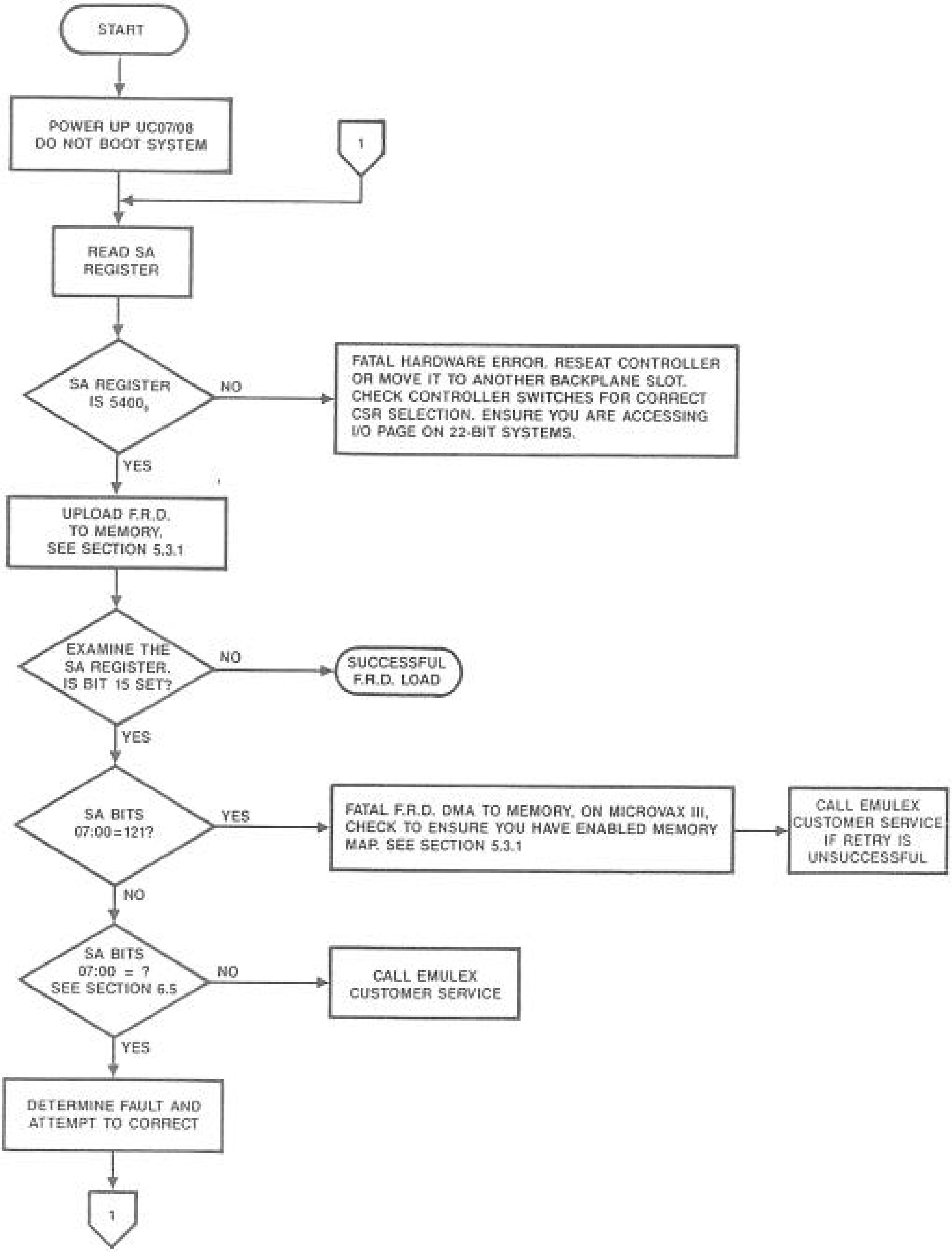

START
POWER UP UC07/08 DO NOT BOOT SYSTEM
1
READ SA REGISTER
SA REGISTER IS 5400$_8$
NO
FATAL HARDWARE ERROR. RESEAT CONTROLLER OR MOVE IT TO ANOTHER BACKPLANE SLOT. CHECK CONTROLLER SWITCHES FOR CORRECT CSR SELECTION. ENSURE YOU ARE ACCESSING I/O PAGE ON 22-BIT SYSTEMS.
YES
UPLOAD F.R.D. TO MEMORY, SEE SECTION 5.3.1
EXAMINE THE SA REGISTER. IS BIT 15 SET?
NO
SUCCESSFUL F.R.D. LOAD
YES
SA BITS 07:00=121?
YES
FATAL F.R.D. DMA TO MEMORY. ON MICROVAX III, CHECK TO ENSURE YOU HAVE ENABLED MEMORY MAP. SEE SECTION 5.3.1
CALL EMULEX CUSTOMER SERVICE IF RETRY IS UNSUCCESSFUL
NO
SA BITS 07:00 = ? SEE SECTION 6.5
NO
CALL EMULEX CUSTOMER SERVICE
YES
DETERMINE FAULT AND ATTEMPT TO CORRECT
1

Figure 6–1. Fault Isolation Chart

6.4 Power-Up Self-Diagnostic

The UC07/08 executes an extensive self-diagnostic to ensure that the host adapter is in good working order. The self-test is divided into several parts. Table 6-1 indicates the order in which the tests are performed.

The first two tests are executed immediately after power-up, a reset, a bus INIT, or a write to the base address register. The other tests are executed as the controller interacts with the MSCP or TMSCP initialization routine. If the UC07/08 fails any of the tests, it posts a fatal error code in the low byte of the SA register (base address plus 2) and turns on all three LEDs. The MSCP and TMSCP fatal error codes used by the UC07/08 are listed in Table 6-2.

To help determine the location of the problem, the operator can select a special diagnostic mode that causes the LEDs to display an error code. To enable this diagnostic mode, halt the CPU. Turn ON SW1-4 (UC07/UC08 Port 1) or SW2-4 (UC07/UC08 Port 2). Next, the host computer must be powered down or the UC07/08 Reset/Halt switch (SW1-1 for UC07/08 Port 1; SW2-1 for Port 2) must be toggled (turned ON and then OFF) to cause the UC07/08 to again perform its self-test.

Upon encountering an error, the host microprocessor halts and the LEDs display an error code. The error codes are listed and described in Table 6-1.

If the UC07/08 completes the diagnostic mode without errors, all three LEDs are OFF. After testing is complete, be sure to turn OFF SW1-4 or SW2-4. Reset the UC07/08 Host Adapter before using it.

Table 6-1. LED Error Codes

	LED		
3	2	1	Error Description
0	0	1	CPU Chip Test failed
0	1	0	SCSI Chip Test failed
1	0	0	Controller idle, waiting for initialization
0	1	1	Buffer Controller or External Memory Test failed
1	0	1	HAC Test failed
1	1	0	Emulation EPROM Checksum Test failed
0	0	0	Self-diagnostic complete without errors
1	1	1	Refer to Table 6-2

NOTE: The UC07/08 might fail the power-up self-diagnostic if the SCSI target device that supplies terminator power to the SCSI bus is powered off. Proper operation of the SCSI bus requires that terminator power be present at all times.

6.5 Fatal Error Codes

If the UC07/08 encounters a fatal error anytime during operation, all three LEDs are illuminated and an error code is posted in the low byte of the SA register (base address plus 2). Table 6-2 lists the MSCP and TMSCP fatal error codes used by the UC07/08.

Table 6–2. MSCP and TMSCP Fatal Error Codes used by UC07/08

Octal Code	Hex Code	Description
0	0	No information in message packet.
1	1	Possible parity or timeout error when the UC07/08 attempted to read data from a message packet.
2	2	Possible parity or timeout error when the UC07/08 attempted to write data to a message packet.
4	4	UC07/08 diagnostic self-test indicated a controller RAM error.
5	5	UC07/08 diagnostic self-test indicated a firmware checksum error.
6	6	Possible parity or timeout error when the UC07/08 attempted to read an envelope address from a command ring.
7	7	Possible parity or timeout error when the UC07/08 attempted to write an envelope address to a command ring.
11	9	Host did not communicate with UC07/08 within the time frame established while bringing the controller online.
12	A	Operating system sent more commands to the UC07/08 than the controller can accept.
13	B	UC07/08 unable to perform DMA transfer operation correctly.
14	C	UC07/08 diagnostic self-test indicated controller fatal error.
16	E	The MSCP or TMSCP connection identifier is invalid.
23	13	An error occurred during the MSCP or TMSCP initialization sequence.

Additional fatal error messages might appear. These error codes are listed in Table 6-3.

Table 6–3. Fatal Error Codes

Octal Code	Hex Code	**Description**
005	05	Firmware checksum error
014	0C	Fatal error during self-test
111	49	Autoboot timeout
121	51	F.R.D. load to memory failed
231	99	SCSI chip failed or no terminator power

Section 7
MSCP/TMSCP COMPATIBILITY AND ODT PROGRAMMING

7.1 Overview

This section contains an overview of the UC07/08 device registers that are accessible to the Q-Bus and that are used to monitor and control the UC07/08 Host Adapter. The registers are functionally compatible with DEC implementations of MSCP controllers.

The following table outlines the contents of this section.

Subsection	Title
7.1	Overview
7.2	Overview of MSCP Subsystem
7.3	MSCP and TMSCP Command Compatibility
7.4	Registers
7.5	Bootstrap Command (Disk Only)

7.2 Overview of MSCP Subsystem

Mass Storage Control Protocol (MSCP) is the protocol used by a family of mass storage controllers and devices designed and built by Digital Equipment Corporation. MSCP allows a host system to be connected to subsystems with a variety of capacities and geometries. This flexibility is possible because MSCP defines data locations in terms of sequential, logical blocks, not in terms of a physical description of the data's location (i.e., cylinder, track, and sector). This scheme gives the MSCP subsystem the responsibility for converting MSCP logical block numbers into physical addresses that the peripheral device can understand.

This technique has several implications. First, the MSCP subsystem must have detailed knowledge of the peripheral's capacity, geometry, and status. Second, the ability to make the translation between logical and physical addresses implies considerable intelligence on the part of the subsystem. Finally, the host is relieved of responsibility for error detection and correction because its knowledge of the media is insufficient to allow error control to be done efficiently.

There are several advantages to this type of architecture. First, it provides the host with an "error-free" media. Second, it provides for exceptional operating system software portability because, with the exception of capacity, the characteristics of all MSCP subsystems are the same from the operating system's point of view.

In terms of implementation, this protocol requires a high degree of intelligence on the part of the subsystem. Essentially, this intelligence is a process that runs on a microprocessor and is referred to as an MSCP controller. The MSCP controller has all of the responsibilities outlined above.

The host computer runs corresponding software processes which take calls from the operating system, convert them into MSCP commands, and cause the resulting command to be transferred to the MSCP controller.

In summary, an MSCP subsystem is characterized by an intelligent controller that provides the host with the view of a perfect media. It is further characterized by host independence from a specific bus, controller, or device type.

7.3 MSCP and TMSCP Command Compatibility

A complete description of MSCP commands and the corresponding status responses which the UC07/08 Host Adapter posts is beyond the scope of this manual.

7.3.1 Command Support

No currently available MSCP Controller supports the entire range of MSCP commands. The following subsections describe the extent of MSCP command support by the UC07/08.

7.3.1.1 Minimal Disk or Tape Subset

The UC07/08 Host Adapter supports the entire minimal disk subset of MSCP commands, and the entire minimal tape subset of TMSCP commands.

7.3.1.2 Diagnostic and Utility Protocol (DUP)

The UC07/08 Host Adapter does not support any of the DUP commands or maintenance read/write commands. Therefore, the UC07/08 is not compatible with DEC diagnostics that use the MSCP or TMSCP DUP commands.

7.4 Registers

During normal operation, the UC07/08 Host Adapter is controlled and monitored using the command and status packets that are exchanged by the Class Driver (host) and the MSCP Controller. The UC07/08 has two 16-bit registers in the I/O page that are used primarily to initialize the subsystem. During normal operation, the registers are used only to initiate polling or to reset the subsystem. These registers are always read as words.

The IP register (base address) has two functions as detailed below:

- When written with any value, it causes a hard initialization of the MSCP Controller.
- When read while the port is operating, it causes the controller to initiate polling.

The SA register (base address plus 2) has three functions as listed below:

- When read by the host during initialization, it communicates data and error information relating to the initialization process.
- When written by the host during initialization, it communicates certain host-specific parameters to the port.
- When read by the host during normal operation, it communicates status information including port and controller-detected fatal errors.

7.5 Bootstrap Command (Disk Only)

To allow the system to be easily bootstrapped from peripherals attached to the UC07/08 Host Adapter, Emulex has incorporated a Bootstrap Command into the controller. This feature is not part of the standard MSCP command set nor is it supported on the MicroVAX or on systems using an 11/73B CPU module.

The Bootstrap Command can be issued from the console after the system is powered up, or it can be incorporated into a firmware routine that is located in a Bootstrap ROM. (The ROM would not be located on the UC07/08 PWB, but on some other module in the system.) The Bootstrap Command causes the UC07/08 to load the first logical block from the selected peripheral into host memory starting at location 00000.

To issue the Bootstrap Command to the UC07/08, at the console emulator prompt, enter the following sequence (operator input is displayed in **boldface**):

```
@7xxxxx/00000 <lf>                        <lf> = LINE FEED
7yyyyy/005400 30003 <cr>                  <cf> = CARRIAGE RETURN
@/000400 40000 <cr>
@RS/456332  304 <cr>
@R0/103741  0 <lf>
R1/001276  772150 <cr>
@0G
```

NOTE: XXXXX and YYYYY are offsets dependent on the address of the UC07/08 controller. See Table 7-1 for the appropriate values.

Table 7-1. LSI-11 Offsets for MSCP Emulations

UC07/08 Bus Address	XXXXX	YYYYY
17772150	72150	72152
17772154	72154	72156
17760334	60334	60336
17760340	60340	60342
17760344	60344	60346
17760350	60350	60352
17760354	60354	60356
17760360	60360	60362
17760364	60364	60366
17760370	60370	60372
17760374	60374	60376
17760400	60400	60402
17760404	60404	60406
17760410	60410	60412
17760414	60414	60416
17760420	60420	60422

Section 8
FUNCTIONAL DESCRIPTION

8.1 Overview

This section contains a description of the UC07/08 Host Adapter's architecture.

8.2 UC07 and UC08 Host Adapter Architecture

The UC07 and UC08 are microprocessor-based host adapters, each of which is contained on a single quadwide PCBA. The UC07 is a single-function host adapter, while the UC08 is a dual-function host adapter that is essentially two UC07s contained on a single PCBA. The remainder of this section describes the architecture of only the UC07; the architecture of each part of the dual-function UC08 is similar. The UC07's major functional blocks are shown in Figure 8–1.

The UC07 Host Adapter is organized around the eight-bit 8031 microprocessor. The board has an eight-bit internal data bus with 16-bit addressing capability. The 8031 addresses the Buffer Controller, the Host Adapter Controller (HAC), and the Emulex SCSI Processor (ESP) as memory (memory-mapped I/O).

The 8031's primary task is to decode and implement commands from the host. At command completion, the microprocessor is also responsible for generating status and transmitting it to the host. A large part of the microprocessor's job while performing those duties involves setting up the HAC and the Buffer Controller for the large data transfers, which are their specialties.

The UC07 uses a 64K Byte erasable programmable read-only memory (EPROM), which contains the firmware (control program). Also, the UC07 has 64K bytes of random access memory (RAM), which is used for data buffering and working storage.

The LSI-11 Bus interface contains 22 lines. Sixteen of the lines are multiplexed for both address and data; six are used for only address. The HAC is used for programmed I/O, CPU interrupts, and DMA data transfers. The microprocessor responds to all programmed I/O and carries out the I/O functions required for the addressed host adapter register. The HAC has automatic LSI-11 Bus address generation capability that, in conjunction with a byte counter, allows the interface to conduct LSI-11 Bus DMA transfers without direct microprocessor intervention after the interface is set up for a transfer. This automatic DMA capability is used with the UC07 Buffer Controller to transfer large blocks of data directly between host memory and the UC07's RAM.

The SCSI interface and control is implemented using a single LSI chip, the ESP. In response to commands from the microprocessor, the chip establishes and monitors SCSI bus phases appropriate to the command, and thus relieves the microprocessor of signal control and timing duties.

The Buffer Controller is implemented on a single chip. This four-channel controller is responsible for moving large blocks of data between the 64K RAM buffer and the SCSI interface, and between the LSI-11 Bus interface and the 64K RAM buffer. After being set up for an operation by the microprocessor, either interface requests DMA service from the Buffer Controller logic by driving an individual request signal active. The transfer then proceeds without direct intervention by the microprocessor. This allows high-speed data transfers to occur while the microprocessor is focused on other processes.

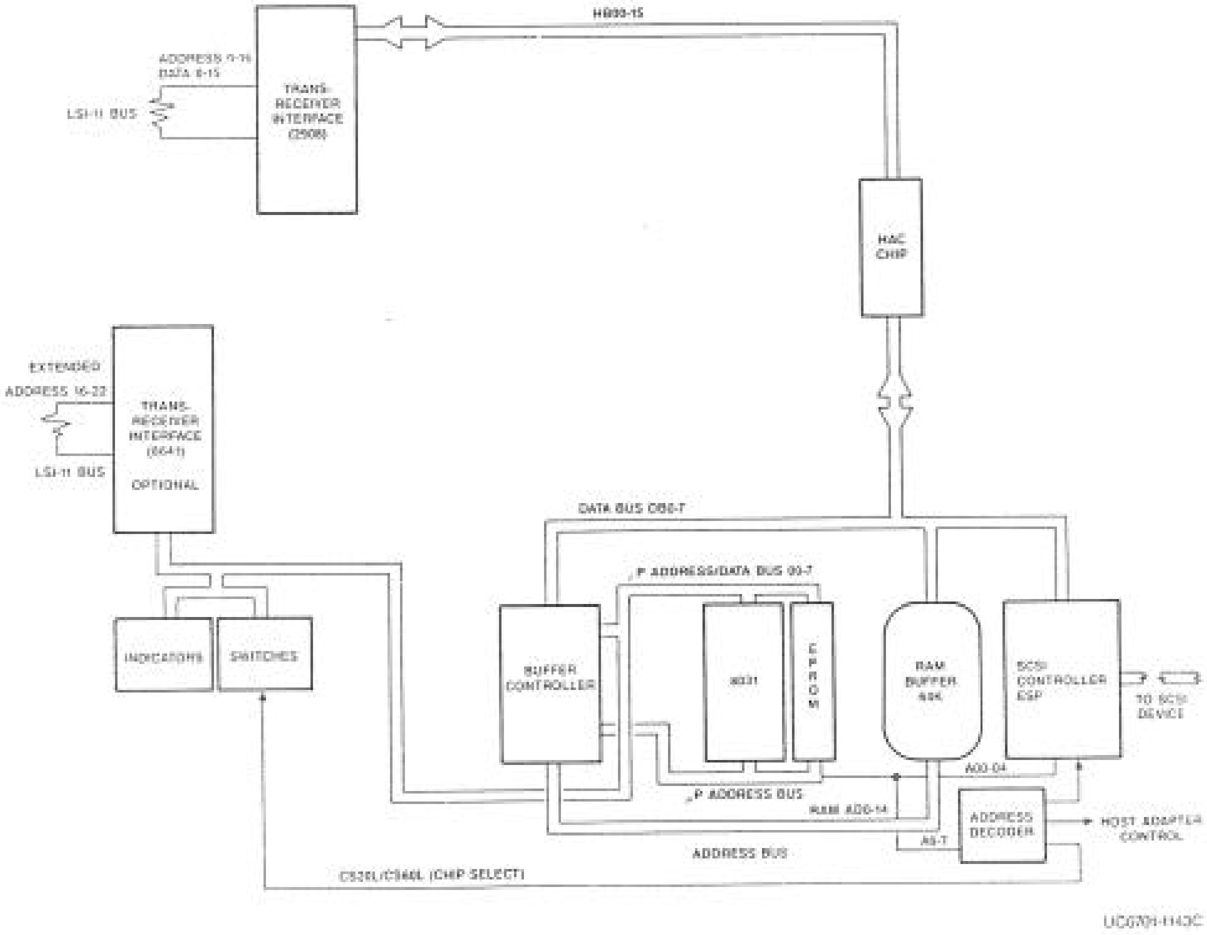


Figure 8–1. UC07 Block Diagram

Section 9
INTERFACES

9.1 Overview

This section describes the interfaces that the host adapter incorporates. It includes information on the host adapter's implementation of SCSI bus specification electrical and mechanical requirements. Including this overview, the section is divided into the following subsections.

Subsection	Title
9.1	Overview
9.2	Host Adapter to Q-Bus Interface
9.3	Host Adapter to SCSI Bus Interface

9.2 Host Adapter to Q-Bus Interface

The Q-Bus between the CPU and the UC07/8 Host Adapter contains 42 bi-directional signal lines and two uni-directional signal lines. Q-Bus interface pin assignments are listed and described in Figure 9-1. These signal lines provide the means by which the CPU and the host adapter communicate with each other.

The Q-Bus interface is used for programmed I/O, CPU interrupts, and DMA data transfer operations. Addresses, data, and control information are sent along these signal lines, some of which contain time-multiplexed information. The Q-Bus interface lines are grouped in the following categories:

- **Twenty-two Address Lines** <BDAL21:BDAL00>. Of these, there are 16 multiplexed data/address lines <BDAL15:BDAL00>; two multiplexed address/parity lines <BDAL17:BDAL16>; and four extended address lines <BDAL21:BDAL18>.
- **Six Data Transfer Control Lines.** BBS7, BDIN, BDOUT, BRPLY, BSYNC, and BWTBT.
- **Ten Interrupt Control and Direct Memory Access Control Lines.** BIAKI, BIAKO, BIRQ4, BIRQ5, BIRQ6, BIRQ7, BDMGO, BDMR, BSACK, BDMGI.
- **Six System Control Lines.** BDCOK, BHALT, BINIT, BEVNT, BPOK, and BREF.

	SIDE 2 (SOLDER SIDE)		SIDE 1 (COMPONENT SIDE)
CONNECTOR A	+5V	A	BIRQ5
		B	BIRQ6
	GND	C	BDAL16
		D	BDAL17
	BDOUT	E	
	BRPLY	F	
	BDIN	H	
	BSYNC	J	GND
	BWTBT	K	
	BIRQ4	L	
	BIAKI	M	GND
	BIAKO	N	BDMR
	BBS7	P	BHALT
	BDMGI	R	BREF
	BDMGO	S	
	BINIT	T	GND
	BDAL00	U	
	BDAL01	V	
CONNECTOR B	+5V	A	BDCOK
		B	BPOK
	GND	C	BDAL18
		D	BDAL19
	BDAL02	E	BDAL20
	BDAL03	F	BDAL21
	BDAL04	H	
	BDAL05	J	GND
	BDAL06	K	
	BDAL07	L	
	BDAL08	M	GND
	BDAL09	N	BSAK
	BDAL10	P	BIRQ7
	BDAL11	R	BEVNT
	BDAL12	S	
	BDAL13	T	GND
	BDAL14	U	
	BDAL15	V	

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Figure 9–1. Q-Bus Interface Pin Assignments

9.2.1 Interrupt Priority Level

The host adapter is jumper-selectable to issue level 4 or level 5 interrupt requests and to monitor levels 5 and 6. The level 4 request is necessary to allow compatibility with an LSI-11 CPU.

9.2.2 Register Address

The host adapter has two registers visible to the Q-Bus. Their addresses are determined by DIP switches. See Section 4 for detailed address and switch setting information.

9.2.3 DMA Operations

All DMA data transfer operations are performed under microprocessor control. When doing a Read From Memory operation, a check is made for memory parity or nonexistent memory (NXM) errors; during a Write operation a check is made for NXM errors. If an error is detected, an MSCP status error is returned.

9.3 Host Adapter to SCSI Bus Interface

This subsection provides information on the host adapter's implementation of SCSI bus electrical and mechanical requirements.

9.3.1 SCSI Interface Physical Description

SCSI bus devices are daisy-chained together using a common cable. Both ends of the cable are terminated. All signals are common between all bus devices. The host adapter supports the SCSI specification single-ended option for drivers and receivers. The maximum cable length allowed for the UC07/008 is 20 feet (six meters); the maximum for the UC06 is 20 meters. This cabling is primarily for interconnection outside the subsystem cabinet in which the host adapter resides.

9.3.1.1 Cable Requirements

A 50-conductor flat cable or 25-twisted-pair flat cable must be used to connect SCSI bus hosts and controllers. The maximum cable length is 20 feet (six meters); the maximum for the UC06 is 20 meters. The maximum length of the cable past the terminator is 0.1 meter. SCSI bus termination can be internal to the SCSI devices that are located at the ends of the bus cable (such as the subsystem that contains the SCSI device controller and its peripheral). The host adapter single-ended pin assignments are shown in Table 9–1.

9.3.1.2 Shielded Connector Requirement

The SCSI bus shielded connector is a 50-conductor cable connector that consists of two rows of 25 female contacts on 100 mil centers. The connector shielding system must provide a DC resistance of less than 10 milliohms from the cable shield at its termination point to the SCSI device enclosure.

9.3.2 SCSI Interface Electrical Description

The host adapter interfaces to SCSI controllers via the SCSI bus. A 50-pin male IDC connector at location J1 on the UC07 board (J1 and J2 on the UC08 board) plugs directly into the SCSI bus (refer to Figure 11–3). All signals use open collector or three-state drivers. Each signal driven by a SCSI device has the following output characteristics when measured at the SCSI device's connection:

- Signal assertion = 0.0 Vdc to 0.4 Vdc

- Minimum driver output capability = 48 milliamperes (sinking) at 0.5 Vdc
- Signal negation = 2.5 Vdc to 5.25 Vdc

All assigned signals are terminated with 220 ohms to +5 volts (nominal) and 330 ohms to ground at each end of the SCSI cable as shown in Figure 9-2.

Each signal received by a SCSI device has the following input characteristics when measured at the SCSI device's connection:

- Signal true = 0.0 Vdc to 0.8 Vdc
- Maximum total input load = -0.4 milliamperes at 0.4 Vdc
- Signal false = 2.0 Vdc to 5.25 Vdc
- Minimum input hysteresis = 0.2 Vdc

Table 9-1. UC07/08 SCSI Bus Pin Assignments

Pin	Signal Name	Input/Output
1	GND	—
2	-D0	Input/Output
3	GND	—
4	-D1	Input/Output
5	GND	—
6	-D2	Input/Output
7	GND	—
8	-D3	Input/Output
9	GND	—
10	-D4	Input/Output
11	GND	—
12	-D5	Input/Output
13	GND	—
14	-D6	Input/Output
15	GND	—
16	-D7	Input/Output
17	GND	—
18	-DP (Data parity)	Input/Output
19	GND	—
20	GND	—
21	GND	—

(Continued on next page)

Table 9–1. UC07/08 SCSI Bus Pin Assignments(Continued)

Pin	Signal Name	Input/Output
22	GND	—
23	GND	—
24	GND	—
25		Not connected
26	TERMPWR	Output
27	GND	—
28	GND	—
29	GND	—
30	GND	—
31	GND	—
32	–ATN	Input/Output
33	GND	—
34	GND	—
35	GND	—
36	–BSY	Input/Output
37	GND	—
38	–ACK	Input/Output
39	GND	—
40	–RST	Input/Output
41	GND	—
42	–MSG	Input/Output
43	GND	—
44	–SEL	Input/Output
45	GND	—
46	–C/D	Input/Output
47	GND	—
48	–REQ	Input/Output
49	GND	—
50	INPUT/OUTPUT	Input/Output

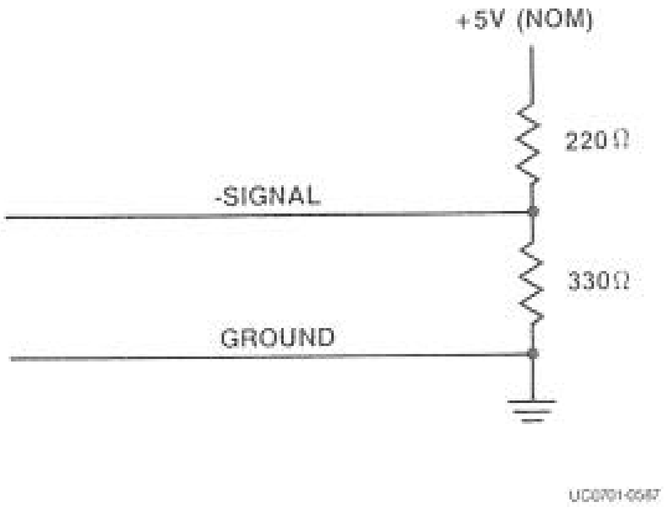


Figure 9–2. UC07/08 SCSI Bus Signals Termination

9.3.3 SCSI Bus Signals and Timing

SCSI bus activities involve one or more of the following SCSI phases of operation:

- Arbitration Phase
- Selection Phase
- Reselection Phase
- Command Phase
- Data Phase
- Status Phase
- Message Phase

The phases are described in subsection 10.3. When the SCSI bus is not involved in one of the above phases, it is in the Bus Free Phase. SCSI phase sequencing is accomplished by asserting or de-asserting the SCSI signals; the signals are described in subsection 10.3.3.1.

9.3.3.1 SCSI Bus Signals

There are 18 signals on the SCSI bus. Nine signals are control signals that coordinate transfer of data between SCSI hosts/ controllers; nine signals are for an eight-bit data bus with parity. The signals are defined in Table 9–2.

In Table 9–2, the eight data bit signals are represented by DB0 through DB7; DB7 is the most significant bit and has the highest priority during the Arbitration Phase. Bit number, significance, and priority decrease downward to DB0. The parity bit, represented by DBP, is odd. The host adapter generates parity which is selected through NOVRAM parameters. Parity is not guaranteed valid during the Arbitration Phase.

The host adapter's SCSI bus pin assignments are listed in Table 9–2; the host adapter supports only the SCSI single-ended option.

Table 9–2. SCSI Bus Signals

Menomonic Name	Signal	Description
DB0	Data Bus	Data Bus Bit 0
DB1	Data Bus	Data Bus Bit 1
DB2	Data Bus	Data Bus Bit 2
DB3	Data Bus	Data Bus Bit 3
DB4	Data Bus	Data Bus Bit 4
DB5	Data Bus	Data Bus Bit 5
DB6	Data Bus	Data Bus Bit 6
DB7	Data Bus	Data Bus Bit 7
DBP	Data Bus	Data Bus Parity
ACK	Acknowledge	Indicates acknowledgement for a REQ/ACK data transfer handshake.
REQ	Request	Indicates a request for a REQ/ACK data transfer handshake.
ATN	Attention	Indicates the ATTENTION condition (i.e., the Initiator has a message to send to the Target). The ATTENTION condition is described in subsection 9.5.2.
RST	Reset	Indicates the RESET condition (i.e., clears the SCSI bus of all activity). The RESET condition is described in subsection 9.5.1.
SEL	Select	Used to select/reselect a SCSI bus device.
BSY	Busy	Indicates the SCSI bus is being used.
C/D	Control/Data	Indicates command/status information transfer or data in/data out transfer.
I/O	Input/Output	Indicates the direction of data movement on the data bus with respect to an Initiator.
MSG	Message	Indicates the SCSI bus is in the Message Phase.
TERMPWR	Termpwr	Provides jumper-selectable termination power to the terminator at the opposite end of the SCSI bus.

9.3.3.2 SCSI Bus Timing

Except where noted, the delay time measurements for each SCSI device (host or controller) are calculated from signal conditions existing at that device's SCSI bus connection. Normally, these measurements do not consider delays in the SCSI cable. The SCSI timings are listed in Table NO TAG.

The timing diagram shown in Figure 9–3 indicates the typical relationship between SCSI bus signals and SCSI phase sequencing.

Table 9–3. SCSI Bus Timings

Timing	Duration	Description
Arbitration Delay	2.2 us	The minimum time a SCSI host or controller waits from asserting the BSY signal for arbitration until the data bus can be examined to see if arbitration has been won. There is no maximum time.
Bus Clear Delay*	800 ns	The maximum time for a SCSI host or controller to stop driving all bus signals after 1) a Bus Free Phase is detected, 2) the SEL signal is received from another SCSI host or controller during the Arbitration Phase.
Bus Free Delay	800 ns	The minimum time a SCSI host or controller waits from its detection of the Bus Free Phase until it asserts the BSY signal when going to the Arbitration Phase.
Bus Set Delay	1.8 us	The maximum time for a SCSI host or controller to assert the BSY signal and its SCSI ID bit on the data bus after it detects a Bus Free Phase for entering the Arbitration Phase.
Bus Settle Delay	400 ns	The time to wait for the SCSI bus to settle after changing certain control signals.
Cable Skew Delay	10 ns	The maximum difference in propagation time allowed between any two SCSI bus signals when measured between any two SCSI devices.
Deskew Delay	45 ns	This time is used to calculate the minimum time required for deskew of signals.
Reset Hold Time	25 us	The minimum time for which the RST signal is asserted. There is no maximum time.
Selection Abort Time	200 us	The maximum time a Target (or Initiator) takes from its most recent detection of being selected (or re-selected) until it asserts the BSY signal. This timeout is required to ensure that a Target (or Initiator) does not assert the BSY signal after a Selection (or Reselection) Phase has been aborted. This is not the Selection timeout.

(Continued on next page)

Table 9–3. SCSI Bus Timings(Continued)

Timing	Duration	Description
Selection Timeout Delaylpq.,	250 ms	The minimum recommended time that an Initiator (or Target) should wait for a BSY response during the Selection or Re-selection Phase before starting the timeout procedure.

ms = milliseconds　　us = micro senconds　　ns= nanoseconds

* In the Bus Clear Delay, for condition 1 the maximum time for a SCSI device to clear the bus is 1200 ns from the BSY and SEL signals both first becoming false. If a SCSI device requires more than a Bus Settle Delay to detect the Bus Free Phase, it clears the bus within a Bus Clear Delay minus the excess time.

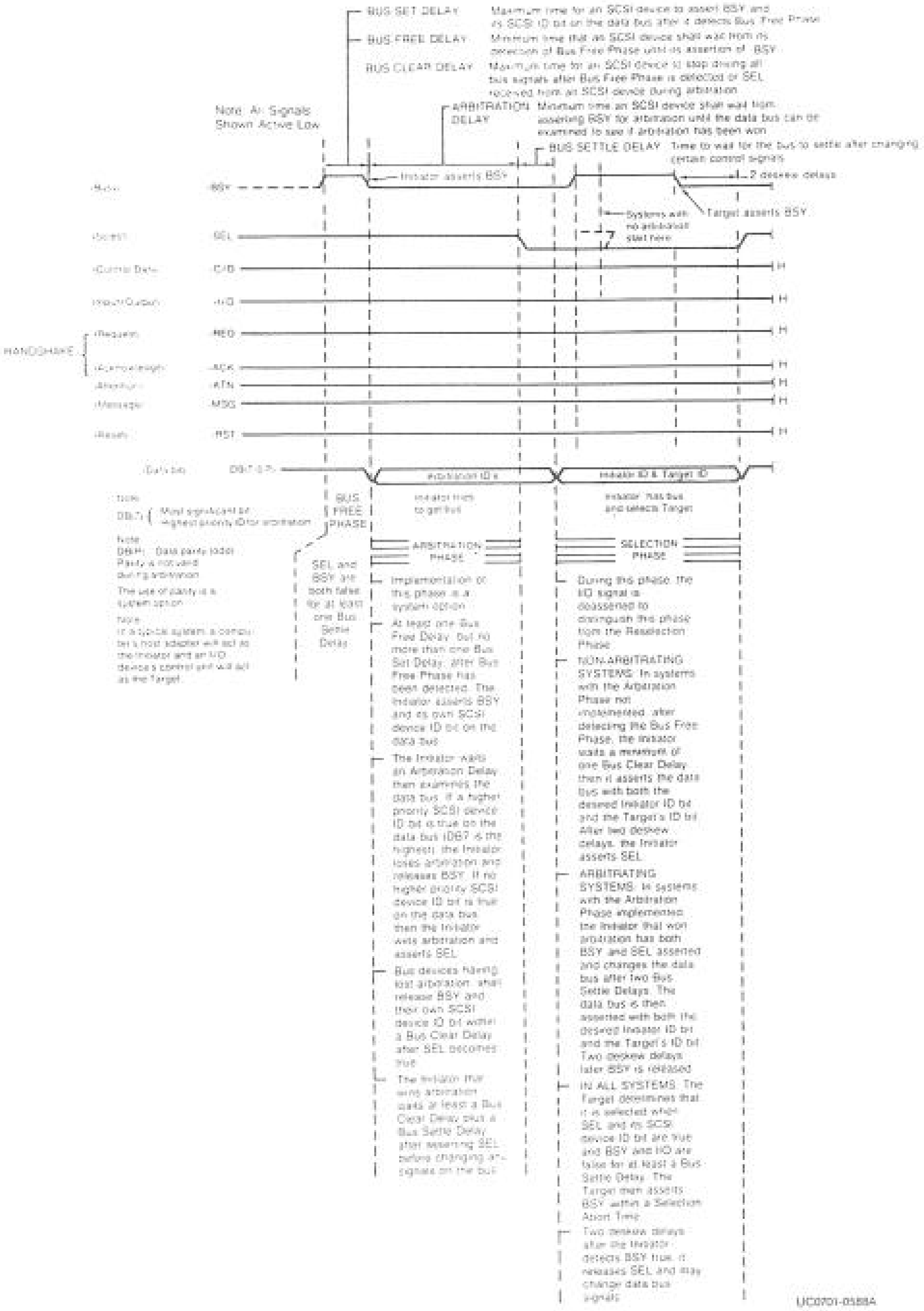
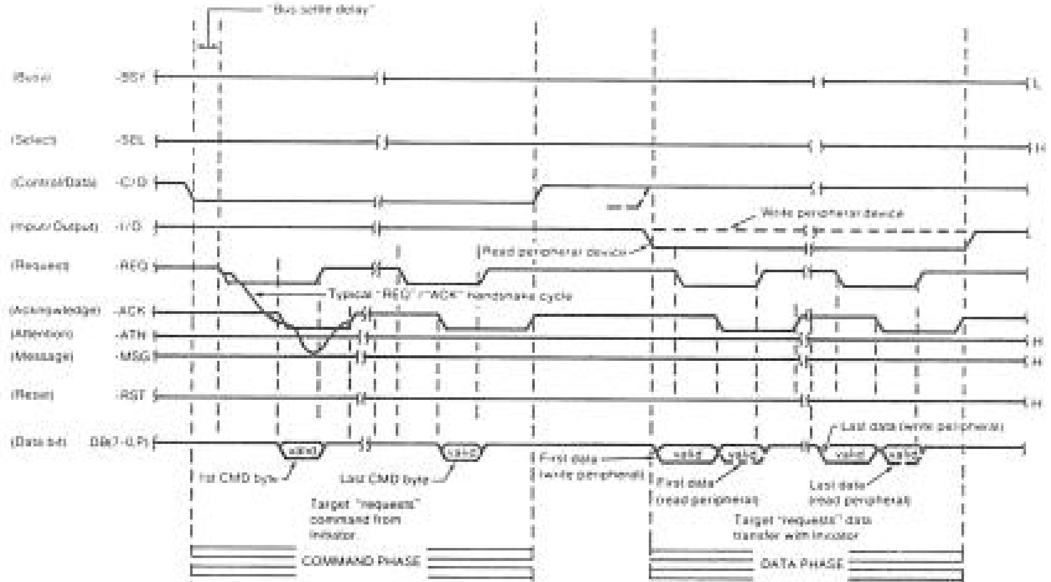

BUS SET DELAY
Maximum time for an SCSI device to assert BSY and its SCSI ID bit on the data bus after it detects Bus Free Phase
BUS FREE DELAY
Minimum time that an SCSI device shall wait from its detection of Bus Free Phase until its assertion of BSY
BUS CLEAR DELAY
Maximum time for an SCSI device to stop driving all bus signals after Bus Free Phase is detected or SEL received from an SCSI device during arbitration
ARBITRATION DELAY
Minimum time an SCSI device shall wait from asserting BSY for arbitration until the data bus can be examined to see if arbitration has been won
BUS SETTLE DELAY
Time to wait for the bus to settle after changing certain control signals
Note: All Signals Shown Active Low
Initiator asserts BSY
2 deskew delays
Systems with no arbitration start here
Target asserts BSY
(Busy)
-BSY
(Select)
-SEL
(Control/Data)
-C/D
(Input/Output)
-I/O
HANDSHAKE
(Request)
-REQ
(Acknowledge)
-ACK
(Attention)
-ATN
(Message)
-MSG
(Reset)
-RST
(Data bus)
DB(7-0,P)
H
H
H
H
H
H
H
Arbitration ID's
Initiator tries to get bus
Initiator ID & Target ID
Initiator has bus and selects Target
Note:
DB(7) Most significant bit highest priority ID for arbitration
Note:
DB(P): Data parity (odd) Parity is not valid during arbitration
The use of parity is a system option
Note:
In a typical system, a computer's host adapter will act as the Initiator and an I/O device's control unit will act as the Target.
BUS FREE PHASE
SEL and BSY are both false for at least one Bus Settle Delay
ARBITRATION PHASE
Implementation of this phase is a system option
At least one Bus Free Delay, but no more than one Bus Set Delay, after Bus Free Phase has been detected. The Initiator asserts BSY and its own SCSI device ID bit on the data bus
The Initiator waits an Arbitration Delay then examines the data bus. If a higher priority SCSI device ID bit is true on the data bus (DB7 is the highest) the Initiator loses arbitration and releases BSY. If no higher priority SCSI device ID bit is true on the data bus then the Initiator wins arbitration and asserts SEL
Bus devices having lost arbitration, shall release BSY and their own SCSI device ID bit within a Bus Clear Delay after SEL becomes true
The Initiator that wins arbitration waits at least a Bus Clear Delay plus a Bus Settle Delay after asserting SEL before changing any signals on the bus
SELECTION PHASE
During this phase, the I/O signal is deasserted to distinguish this phase from the Reselection Phase
NON-ARBITRATING SYSTEMS: In systems with the Arbitration Phase not implemented, after detecting the Bus Free Phase, the Initiator waits a minimum of one Bus Clear Delay then it asserts the data bus with both the desired Initiator ID bit and the Target's ID bit. After two deskew delays, the Initiator asserts SEL
ARBITRATING SYSTEMS: In systems with the Arbitration Phase implemented the Initiator that won arbitration has both BSY and SEL asserted and changes the data bus after two Bus Settle Delays. The data bus is then asserted with both the desired Initiator ID bit and the Target's ID bit. Two deskew delays later BSY is released
IN ALL SYSTEMS: The Target determines that it is selected when SEL and its SCSI device ID bit are true and BSY and I/O are false for at least a Bus Settle Delay. The Target then asserts BSY within a Selection Abort Time
Two deskew delays after the Initiator detects BSY true, it releases SEL and may change data bus signals
UC0701-0588A

Figure 9–3. SCSI Bus Timing Diagram (Sheet 1 of 3)



The Target asserts C/D and deasserts I/O and MSG for all of the handshakes of this phase.

The transfer is from Initiator to Target.

HANDSHAKE PROCEDURE:

The Target asserts REQ. The Initiator drives data (7-0,P) to their desired values, waits at least one deskew delay plus a cable skew delay, and asserts ACK. The Initiator continues to drive data (7-0,P) until REQ is false.

When ACK is true at the Target, the Target reads the data (7-0,P), then asserts REQ.

When REQ becomes false at the Initiator, the Initiator may change or release data (7-0,P) and deassert ACK.

The Target continues requesting command bytes. The number of bytes depends on the command group code detected from the first command byte received.

DATA IN PHASE: Read Peripheral

Data is to be sent from Target to Initiator.

Target asserts I/O, deasserts C/D, and MSG during the REQ/ACK handshake of this phase.

HANDSHAKE PROCEDURE

The Target first drives data (7-0,P) to their desired values, waits at least one deskew delay plus a cable skew delay, then asserts REQ. Data (7-0,P) shall remain valid until ACK is true at the Target.

The Initiator shall read data (7-0,P) after REQ is true, then asserts ACK.

When ACK becomes true at the Target, the Target may change or release data (7-0,P) and deassert REQ.

After REQ is false, the Initiator deasserts ACK. After ACK is false, the Target may continue the transfer by driving data (7-0,P) and asserting REQ.

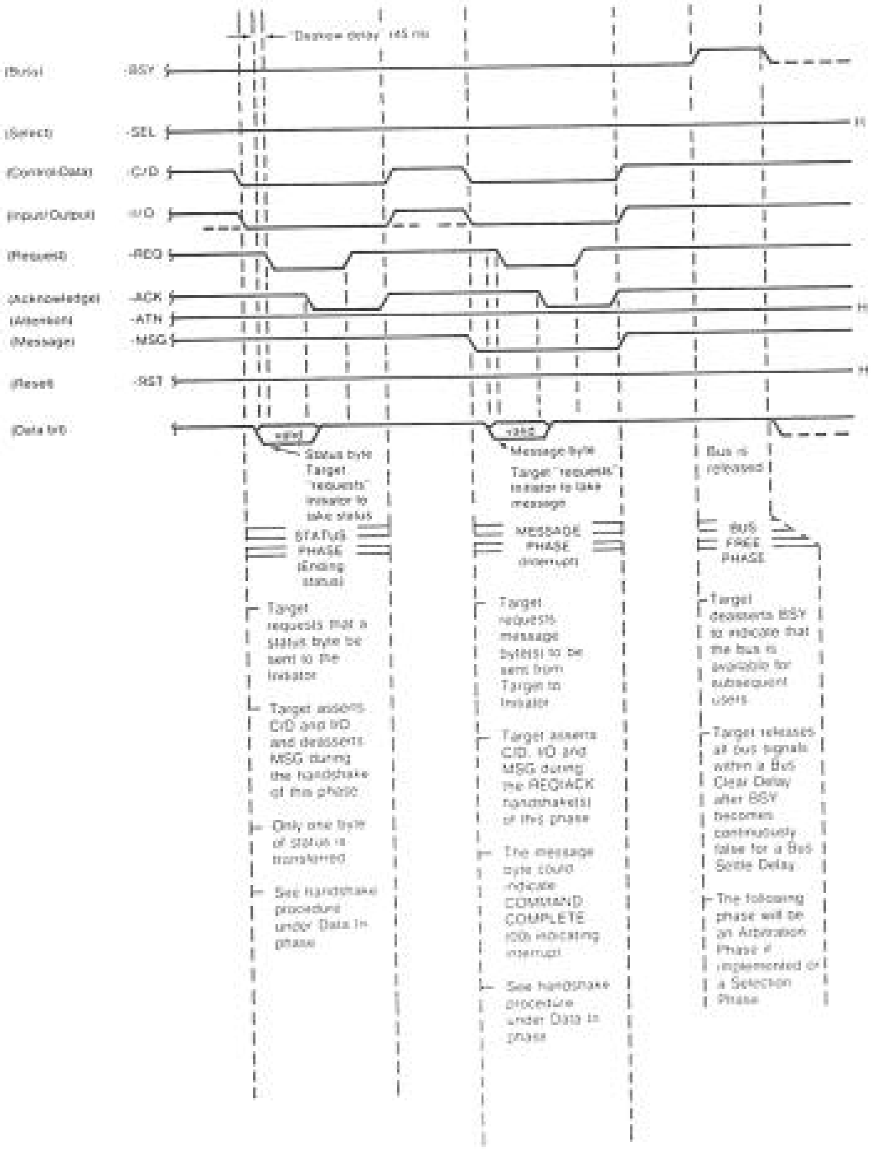
DATA OUT PHASE: Write Peripheral

Data is to be sent from Initiator to Target.

Target deasserts C/D, I/O and MSG during the REQ/ACK handshake of this phase. Refer to the handshake procedure of the Command Phase.

UC0701-0588B

Figure 9–4. SCSI Bus Timing Diagram (Sheet 2 of 3)


"Deskew delay" (45 ns)
(Busy) -BSY
(Select) -SEL
(Control/Data) -C/D
(Input/Output) -I/O
(Request) -REQ
(Acknowledge) -ACK
(Attention) -ATN
(Message) -MSG
(Reset) -RST
(Data bit)
H
H
H
valid
valid
Status byte
Target "requests" initiator to take status
STATUS PHASE (Ending status)
Target requests that a status byte be sent to the initiator
Target asserts C/D and I/O and deasserts MSG during the handshake of this phase
Only one byte of status is transferred
See handshake procedure under Data In phase
Message byte
Target "requests" initiator to take message
MESSAGE PHASE (interrupt)
Target requests message byte(s) to be sent from Target to Initiator
Target asserts C/D, I/O and MSG during the REQ/ACK handshake(s) of this phase
The message byte could indicate COMMAND COMPLETE (00) indicating interrupt
See handshake procedure under Data In phase
Bus is released
BUS FREE PHASE
Target deasserts BSY to indicate that the bus is available for subsequent users
Target releases all bus signals within a Bus Clear Delay after BSY becomes continuously false for a Bus Settle Delay
The following phase will be an Arbitration Phase if implemented or a Selection Phase

UC0701-0588C

Figure 9–5. SCSI Bus Timing Diagram (Sheet 3 of 3)

Section 10
SCSI PROTOCOL DESCRIPTION

10.1 Overview

This section describes the SCSI bus; it includes information on SCSI bus phases and phase sequencing, as well as the procedures for passing control and status information between SCSI bus hosts and controllers using SCSI memory address pointers. Finally, it also describes in detail the SCSI commands issued by the UC07/08. This section is divided into the following subsections:

Subsection	Title
10.1	Overview
10.2	SCSI Bus Overview
10.3	SCSI Bus Phases
10.4	SCSI Bus Phase Sequencing
10.5	SCSI Bus Conditions
10.6	SCSI Commands
10.7	SCSI Group Code 0 Command Descriptions
10.8	SCSI Group Code 1 Command Descriptions
10.9	SCSI Group Code 7 Command Descriptions

10.2 SCSI Bus Overview

The Small Computer System Interface (SCSI) is a standard interface established to support mass storage, printer output, and network communication for microcomputers and minicomputers. The interface is an eight-port, daisy-chained bus. The UC07/08 SCSI command standard is based on the ANSI X3T9.2/82-2 Revision 17B (16 Dec. 85) SCSI Interface Specification and the industry-standard SCSI Common Command Set (CCS).

Up to eight SCSI hosts and/or controllers can be supported by the SCSI bus. Each controller can be connected to a maximum of eight devices (called Logical Unit Numbers, or LUNs). Three basic SCSI configurations are supported with the UC07/08 and the SCSI bus; they are listed below:

- single initiator, single target
- single initiator, multi-target
- multi-initiator, multi-target

Communication on the SCSI bus occurs between a host and a controller. When a host and a controller communicate, one acts as the Initiator and one as the

Target. The Initiator (usually the host, the UC07/08) originates an operation and the Target (usually a peripheral controller) performs the operation. Sample system configurations supported by UC07/08 hardware are shown in Figure 10-1.

Some SCSI bus functions are assigned to the Initiator and some functions to the Target. The Initiator can arbitrate for control of the SCSI bus and select a specific Target. The Target can request the transfer of command, data, status, or other information on the SCSI data bus. In some cases, the Target can arbitrate for control of the SCSI bus to reselect an Initiator and continue an operation.

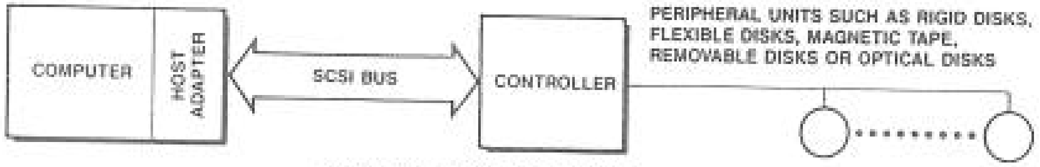
SCSI bus data transfers are asynchronous or synchronous and follow a defined REQ/ACK (request/acknowledge) handshake protocol. (This protocol is defined in the ANSI SCSI specification.) One eight-bit byte of information can be transferred with each handshake or multiple requests can be performed in synchronous mode.

The SCSI bus consists of 18 signals. Nine signals are for an eight-bit data bus with parity; the other nine signals are for control signals that coordinate data transfer between the host and SCSI controllers. SCSI bus signals are described in detail in subsection 9.3.3.1.

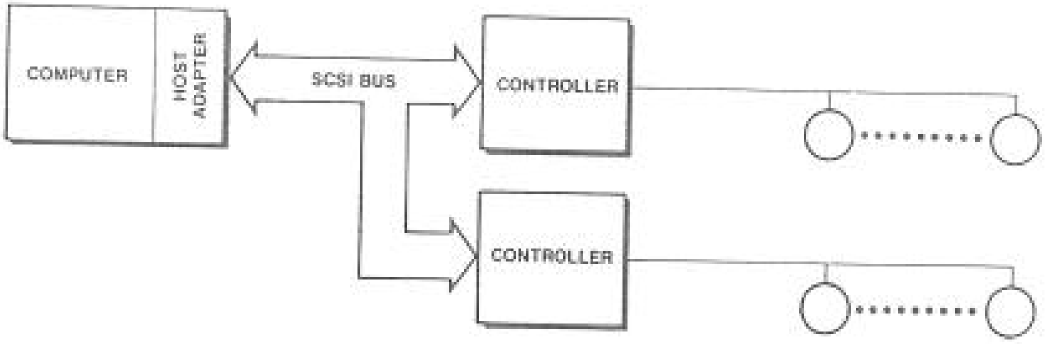
10.2.1 Technical Manual Conventions

To avoid possible confusion with other uses of the same words, throughout this section we use the following conventions:

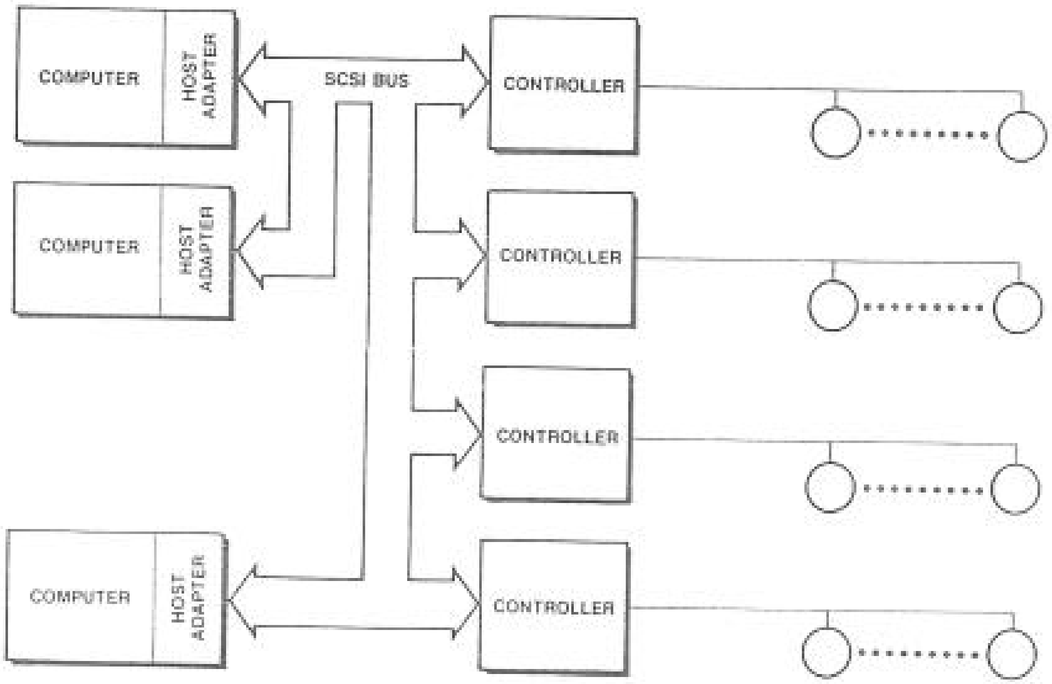
- All SCSI commands (such as **READ, MODE SELECT, and INQUIRY**) and diagnostic subcommands (such as **READ BAD SECTOR FILE** and **WRITE LONG**) are printed in uppercase boldface.
- All SCSI status and error messages (such as CHECK CONDITION and DRIVE NOT READY) are printed in uppercase.
- All SCSI bus phases and conditions (such as Arbitration Phase) and SCSI Command Descriptor Block names (such as Extended Sense Byte) are printed in initial caps.
- All SCSI command and message codes are given in their hexadecimal values.


COMPUTER
HOST ADAPTER
SCSI BUS
CONTROLLER
PERIPHERAL UNITS SUCH AS RIGID DISKS, FLEXIBLE DISKS, MAGNETIC TAPE, REMOVABLE DISKS OR OPTICAL DISKS

SINGLE INITIATOR, SINGLE TARGET



SINGLE INITIATOR, MULTI TARGET



MULTI INITIATOR, MULTI TARGET

UC0701-2062

Figure 10–1. Sample SCSI Bus Configurations

10.3 SCSI Bus Phases

The activities on the SCSI bus can be divided into the following phases of operation:

- Arbitration
- Selection
- Re-selection
    - Command
    - Data
    - Status
    - Message

These phases are supported as specified by the ANSI SCSI specification. The phases are individually discussed in subsequent subsections. The last four phases (Command, Data, Status, and Message) are grouped together as Information Transfer Phases.

When the SCSI bus is not involved in one of the SCSI bus phases, it is in a Bus Free Phase. The Bus Free Phase indicates that no host adapter or controller is actively using the SCSI bus and the SCSI bus is available for subsequent users.

The SCSI bus activities, implemented by the UC07/08, include the disconnect function and re-selection function (see subsection 10.3.2). Overlapped operations on multiple controllers and multiple logical units are supported.

In the following subsections, no attempt is made to detail the SCSI bus signal sequences; the signals and timing are listed in subsection 9.3.3.

10.3.1 Arbitration Phase

The Arbitration Phase is an optional implementation on the SCSI bus. This phase is used when multiple controllers or processors contend for SCSI bus ownership. Since multiple host adapters and/or controllers might desire control of the SCSI bus concurrently, arbitration for the SCSI bus is a requirement for controllers attached to the UC07/08.

10.3.2 Selection and Re-selection Phases

The SCSI bus Selection and Re-selection phases provide methods for establishing a link between the Initiator and a desired Target.

After the UC07/08 selects a target to perform some function (for example, read or write data), the target has the option of disconnecting from the SCSI bus. When the target needs to re-establish the link to its original Initiator, it reselects that Initiator.

The SCSI Selection and Re-selection Phases can be terminated for any one of three conditions:

1. The preceding Selection or Re-selection Phase is successfully completed by using the Selection/Re-selection handshake protocol.
2. A Selection/Re-selection timeout occurs. The timeout results if any Target or Initiator does not respond to the Selection/Re-selection Phase within a timeout period of two seconds.
3. A Reset (-RST) signal occurs on the SCSI bus. When this signal is asserted, all SCSI bus sequences are immediately terminated and the SCSI bus signals are released by all Initiators and Targets.

The Initiator uses the Attention (-ATN) signal to notify the target that a message is ready. To guarantee that the Target recognizes the Attention condition before the Command Phase is entered, the -ATN signal level is held true before the Selection or Re-selection Phase is completed.

If an IDENTIFY message is used during the Selection Phase sequence, the specified Logical Unit Number (LUN) has precedence over the LUN field in the Command Descriptor Block (CDB). (CDBs are described in detail in subsection 10.6.) The IDENTIFY message also informs the Target if the Initiator supports the disconnect function.

10.3.3 Information Transfer Phases

The Command, Data, Status, and Message Phases are grouped together as Information Transfer Phases because they are all used to transfer data or control information via the SCSI data bus. The Information Transfer Phases are described in the following subsections.

10.3.3.1 Command Phase

The Command Phase allows the Target to request command information from the Initiator. An Initiator issues SCSI commands to a Target by transferring a command packet, called a Command Descriptor Block (CDB). The length of the SCSI command and the meaning of the information in the command packet depends on which command is being transferred. (See subsection 10.6 for definitions of SCSI commands and all SCSI CDBs supported by the UC07/08.)

The Command Phase is interrupted only for the following exception conditions:

- **Reset Condition.** This condition can occur when the SCSI Reset (–RST) signal is asserted or a power fail or power-off condition in the Target occurs. In this case, the Command Phase and the connection established during the Selection/Re-selection Phase is terminated by the Target with the release of the –BSY signal.
- **Parity Error Condition.** The Target detects a parity error on the SCSI bus during the command transfer operation. At this time, the target controller releases the –BSY signal, terminates the connection, and the SCSI bus returns to the Bus Free phase.

10.3.3.2 Data Phase

The Data Phase of a connection controls the transfer of data between the Initiator and Target devices. The Data Phase includes both the Data In Phase and the Data Out Phase. The Data In Phase allows the Target to request sending of data to the Initiator from the Target. The Data Out Phase allows the Target to request sending of data to the Target from the Initiator. The direction of the data transfer operation depends on the command being processed. Some commands might have no data to be transferred and, therefore, have a null Data Phase. Synchronous and asynchronous data transfer mode are supported by the UC07/08.

The Data Phase is interrupted only for the following exception conditions:

- **Reset Condition.** This condition can occur when the SCSI Reset (–RST) signal is asserted or when a power fail or power-off condition in the Target occurs. In this condition, the Data Phase and the connection established during the Selection/Re-selection Phase are terminated by the Target with the release of the –BSY signal.
- **Data Out Parity Error Condition.** The Target detects a parity error on the SCSI bus during the data transfer operation from the Initiator to the Target.
- **Data In Parity Error Condition.** The Initiator detects a parity error on the SCSI bus during the data transfer operation from the Target to the Initiator. The Initiator can then assert the –ATN signal along with the Acknowledge (–ACK) signal. The Target detects this condition and enters the message out phase to receive a message. The Initiator sends an Initiator-detected error message in response.

10.3.3.3 Status Phase

The Status Phase is used by the Target to send completion information to the Initiator. The status is sent in a single byte, the format of which is defined in subsection 10.3.3.3.1.

The Target can initiate the Status Phase when any one of the following conditions occur:

- **Busy Status.** The Selection Phase is completed and the Target is in a BUSY state and unable to process any commands for an extended period of time. The Target can initiate the Status Phase immediately after this condition occurs. The Status Byte transferred has the BUSY status code set.
- **Reservation Conflict Status.** The Command or Re-selection Phase is completed and the specified LUN is reserved for another Initiator. The Status Byte transferred has the RESERVATION CONFLICT status code set.
- **Terminated Status.** At the termination of a command, the Status Byte transferred has the GOOD STATUS code set to indicate the success of the command.

NOTE: In multi-Initiator environments, the Initiator delays a minimum of 200 microseconds before attempting another selection of a Target if a BUSY status code for that Target is received.

10.3.3.3.1 Status Byte Format

The format of the Status Byte used by the Target to send completion information to the Initiator is defined below.

Byte	Bit	07	06	05	04	03	02	01	00
00		0	0	0		Status Code			NED

Status Code - Bits <04:01>

These bits are used to specify the status code. Table 10-1 lists and describes the status codes that are recognized by the UC07/08.

Nonexistent Device (NED) - Bit 00

When the NED bit is set to one, the Initiator selected a LUN that is not configured in the system.

Table 10–1. Status Codes

Bits 04	 03	 02	 01	Status	Description
X	0	0	0	GOOD STATUS	The target controller successfully completed the command.
0	0	0	1	CHECK CONDITION	An error, exception, or abnormal condition occurred.
0	1	0	0	BUSY	The target controller is busy.
1 = Set		0 = Cleared		X= Don't Care	

10.3.3.4 Message Phase

The Message Phase is used to transfer information about exception conditions between the Initiator and the Target. The Message Phase includes both the Message In and the Message Out Phases. The Message In Phase allows a Target to request that messages be sent to the Initiator from the Target. The Message Out Phase allows a Target to request that messages be sent from the Initiator to the Target. Table 10–2 lists the error messages that are supported by the UC07/08. Unsupported messages will cause the UC07/08 to abort and restart the command.

Table 10–2. UC07/08 SCSI Messages

Code	Message	Description
00	COMMAND COMPLETE	Issued by the Target just before releasing the -BSY signal at the end of a command execution. This message is generally sent immediately after a Status Phase.
01	EXTENDED	Used for synchronous Data Transfer Request.
02	SAVE DATA POINTER	Issued by the Target to direct the Initiator to save a copy of the present active data pointer.
03	RESTORE DATA POINTER	
04	DISCONNECT	Issued by the Target just before releasing the -BSY signal to indicate to the Initiator that the present physical connection is temporarily broken. The current data, command, and status pointers are not saved.
06	ABORT	Issued by the Initiator to the Target to clear the specified LUN and cause the SCSI bus to go to the Bus Free Phase.
07	MESSAGE REJECT	Issued by the Initiator or Target in response to a received message that was undefined.
09	MESSAGE PARITY ERROR	
0C	BUS DEVICE RESET	Issued by the Initiator to the Target to reset all current I/O activities on the SCSI bus. This message generates a hard Reset Condition (see subsection 10.5.1).
80–FF	IDENTIFY*	Issued by the Target or Initiator to establish a connection to a particular LUN. The following bits have particular meaning: Bit 07 – Always set to one. Bit 06 – Set if the Initiator can support Disconnect and Reconnect sequences. Bits < 02:00 > – Specify LUN address (hexadecimal) in a Target.

* If the disconnect function is supported, this message will be issued by the UC07/08 at the beginning of every command sequence.

10.4 SCSI Bus Phase Sequencing

The status of the SCSI bus is a function of the control signals. These signals place the bus in one of four phases: Arbitration, Selection/Re-selection, Information Transfer, and Bus Free. The order in which SCSI bus phases are used follows a prescribed sequence, shown in Figure 10-2.

All SCSI command sequences start with the Bus Free Phase. The normal progression is from the Bus Free Phase to the Arbitration Phase. During arbitration, hosts/controllers contest for control of the SCSI bus; priority is given to the one with the highest SCSI bus address.

Once a host or controller has control of the SCSI bus, the bus enters the Selection/Re-selection Phase. This phase allows the master of the bus to select a specific device for communication. An Initiator can select a Target to initiate an operation, or a Target can reselect an Initiator to continue an operation.

After a physical path between an Initiator and a Target is established, the bus moves into one of the Information Transfer Phases. These phases include six types of information exchange:

- Data Out Phase
- Data In Phase
- Command Phase
- Status Phase
- Message In Phase
- Message Out Phase

These types of SCSI bus information exchange are described in more detail in subsection 10.3.

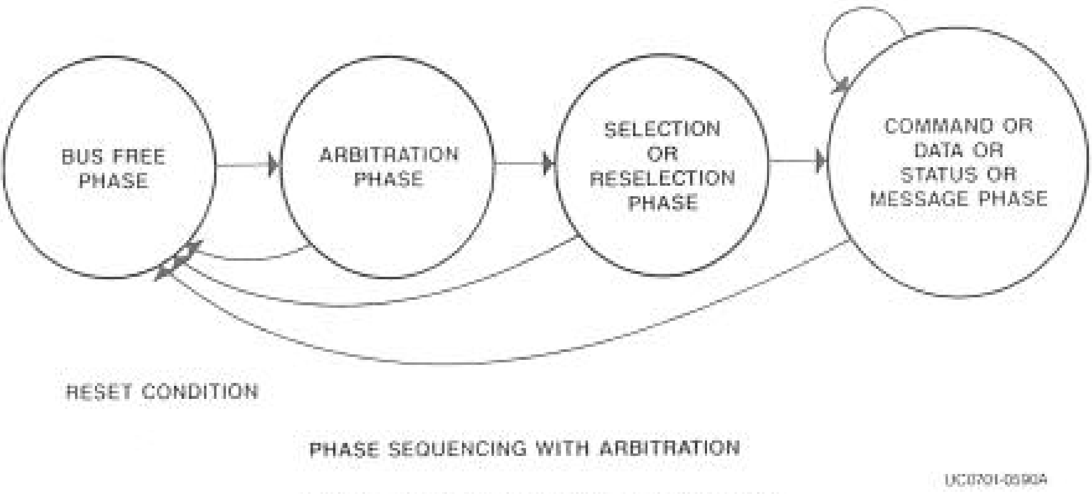

BUS FREE PHASE
ARBITRATION PHASE
SELECTION OR RESELECTION PHASE
COMMAND OR DATA OR STATUS OR MESSAGE PHASE
RESET CONDITION
PHASE SEQUENCING WITH ARBITRATION
UC0701-0590A

Figure 10-2. SCSI Bus Phase Sequences

10.5 SCSI Bus Conditions

The SCSI bus has the following asynchronous conditions:

- Reset Condition
- Attention Condition

These conditions cause certain SCSI device actions and can alter the phase sequence. The two conditions are discussed in the subsections below.

10.5.1 Reset

The Reset Condition is used to immediately clear all bus masters from the SCSI bus. This condition takes precedence over all other SCSI bus phases and conditions. During the Reset Condition, no bus signal except RST is guaranteed to be valid.

The UC07/08 supports a "hard" reset option. When the target detects a Reset Condition, it should perform the following actions:

- Clear all uncompleted commands
- Release device reservations
- Return device operating modes (such as the MODE SELECT command) to their default conditions

The UC07/08 will re-submit outstanding commands to the target after the reset condition clears.

10.5.2 Attention

The Attention Condition allows an Initiator to inform a Target that the Initiator has a message ready. The Target can obtain this message in the Message Phase.

10.6 SCSI Commands

An Initiator (such as the UC07/08) issues SCSI commands to a Target device by transferring a command packet, called a Command Descriptor Block (CDB). The command contained in the CDB determines the length of the CDB. The first byte of a CDB contains the command. This byte, called the Operation Code, has two components: the Group Code and the Command Code.

The UC07/08 issues Group Code 0, Group Code 1, and Group Code 7 SCSI commands to the target controller. Group Code 0 CDBs contain six bytes and

Group Code 1 CDBs contain ten bytes. Group Code 7 CDBs, which are vendor unique and are 10 bytes long. The Command Code defines the type of SCSI command. SCSI command types are defined as specific CDB bit patterns in the ANSI SCSI specification; CDBs issued by the UC07/08 follow the guidelines listed in the ANSI SCSI specification.

NOTE: The commands listed apply to Emulex controllers (Medalist and Champion). Other controllers might handle some of the commands slightly differently. See the manufacturer's manuals for details.

The structure of each SCSI command packet that can be issued by the UC07/08 is shown in the applicable descriptions in subsection 10.7 (Group Code 0 CDBs), 10.8 (Group Code 1 CDBs), and 10.9 (Group Code 7 CDBs). The following table lists, by subsection number, command names and operation codes for SCSI commands issued by the UC07/08:

Subsection	UC07/08 SCSI Command	Opcode (Hexadecimal)
10.7.1	FORMAT UNIT	04
10.7.2	INQUIRY	12
10.7.3	REWIND (Tape only)	01
10.7.4	MODE SELECT	15
10.7.5	MODE SENSE	1A
10.7.6	READ (Tape)	08
10.7.7	READ (Disk)	08
10.7.8	RE-ASSIGN BLOCK	07
10.7.9	REQUEST SENSE	03
10.7.10	START/STOP UNIT	1B
10.7.11	TEST UNIT READY	00
10.7.12	WRITE FILEMARKS (Tape only)	10
10.7.13	SPACE (Tape only)	11
10.7.14	ERASE (Tape only)	19
10.7.15	LOAD/UNLOAD (Tape only)	1B
10.7.16	WRITE (Tape)	0A
10.7.17	WRITE (Disk)	0A
10.8.1	READ CAPACITY	25
10.8.2	READ (EXTENDED)	28
10.8.3	WRITE (EXTENDED)	2A
10.9.1	READ LONG	E8
10.9.2	WRITE LONG	EA

10.7 SCSI Group Code 0 Command Descriptions

This subsection provides detailed descriptions of SCSI Group Code 0 commands, including CDB formats, hexadecimal operation codes, byte and bit functions, and any necessary effects produced by the commands. Each SCSI command is described in a separate subsection.

A sample Group 0 CDB is shown in Figure 10–3. The first byte of a command (Byte 00) contains two fields: the Group Code in the high-order three bits (bits <07:05>), and the Command Code in the low-order five bits (bits <04:00>). The Group Code determines the length of the command packet in the CDB, and together the Group and Operation Codes determine the operation to be performed.

Bits <7:05> of byte 01 in the CDB contain the LUN of the device being addressed. The UC07/08, acting as a SCSI bus Initiator, supports up to eight LUNs: eight disk drives assuming they are not split, or one tape drive. The LUN must be specified for all commands. The definition of the low-order bits in byte 01 is based on the current command.

Byte	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
00	Group Code			Command Code				
01	LUN			Command-Dependent Parameters				
02	Command-Dependent Parameters							
03	Command-Dependent Parameters							
04	Command-Dependent Parameters							
05*	0	0	0	0	0	0	0	0
* Control byte. The control byte is always zero (0).								

Figure 10–3. Sample Group 0 Command Descriptor Block

10.7.1 Format Unit (Opcode 04H)

The **FORMAT UNIT** CDB, shown below, is used to write header and data blocks on the entire disk. This command normally writes all header fields and initializes data fields. This command is described as it relates to Medalist and Champion controllers. Other controller types are similar, but consult the manufacturer's manuals for differences.

Byte	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
00	0	0	0	0	0	1	0	0
01	LUN			FMD	CPL	Defect List Format		
02	0	0	0	0	0	0	0	0
03	0	0	0	0	0	0	0	0
04	Interleave Code (LSB)							
05	0	0	0	0	0	0	0	0

The command in this CDB can disconnect from the Initiator.

Logical Unit Number (LUN) - Byte 01, Bits <07:05>

These bits specify the LUN of the addressed device for this command.

Format Data (FMD) - Byte 01, Bit 04

When the FMD bit status is set to one, **FORMAT UNIT** data is supplied during the Data Out Phase of the command. No defect list will be supplied with this data. See Table 10-3 for an explanation of how this bit affects the format mode.

Complete List (CPL) - Byte 01, Bit 03

This bit is always set to one, and indicates that any previous Defect Map or defect data is erased. The Target must create a Defect List as it formats the media.

Defect List Format - Byte 01, Bits <02:00>

These bits specify additional information related to the format of the Defect List. Together with the FMD and CPL bits, these bits specify the mode of a Format operation. The Format modes are listed in Table 10-3. Only the block address mode is supported.